SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, FEBRUARY 3, 1905.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

*THE NATIONAL BUREAU OF STANDARDS AND ITS RELATION TO SCIENTIFIC AND TECHNICAL LABORATORIES.**

THE dedication of a large and well-appointed building to be devoted exclusively to instruction and research in physics is a notable event in the history of a college. In this instance it is the realization of a hope long cherished by many, and by none more than by the present speaker. That so splendid a building has been deemed necessary for the work to be done in physics suggests two things. First, the high standard which Wesleyan is setting for herself in this as in other departments of work, and, second, the rapid development which has occurred in recent years in physics, rendering imperative an equipment for experimental work of an entirely different order of magnitude from that thought sufficient a generation ago. So great has been the demand for the best instruments and standards to be used in experimental work, both in pure and in applied physics, that the government has been led to establish at Washington a national laboratory, one of whose functions is to cooperate with scientific and technical institutions and manufacturers in the work of improving instruments and standards and developing methods of measurement. It, therefore, seems not inappropriate that something be said on this occasion concerning this work of the national government, so recently in-

* An address delivered at the opening of the John Bell Scott Memorial Laboratory of Physical Science, at Wesleyan University, Middletown, Conn., December 7, 1904.

augurated as not to be generally known.

The bureau of standards was established by act of congress in response to a demand for such an institution on the part of many scientists, engineers, manufacturers and representatives of the national government. The high order of accuracy required in modern engineering practise and in scientific research made it more than ever necessary that manufacturers of scientific and engineering instruments should possess correct standards of length, mass and volume, as well as electrical, optical and thermometric standards, and be able to have them reverified from time to time. It was also important that any one engaged in scientific or engineering work could have his instruments and standards tested whenever necessary. The office of weights and measures, at Washington, had been equipped to do some of the work required in the verification of length, mass and volume for many years, but it was necessary to send electrical standards, thermometers and pyrometers and many other kinds of apparatus to Europe to be tested when results of the highest accuracy were desired. As this was both expensive and time consuming the consequence was that only infrequently were these more accurate tests obtained. The United States held a creditable position among the nations of the earth in physical science, and had some of the best physical laboratories in the world; it was leading the world in the manufacture of electrical machinery and some kinds of electrical instruments. To be obliged to ask the German imperial or other foreign laboratories to do our testing for us, because we lacked a well-equipped national laboratory for doing such work, was clearly a situation that ought to be corrected, and congress acted promptly when the importance of the matter was brought to its attention. Appropriations were made for laboratory buildings and equipment and for a director and a small scientific staff, and the bureau began its work July 1, 1901. President McKinley appointed as director Professor S. W. Stratton, of Chicago University, to whom more than to any one else is due the credit for the establishment and the success of the bureau. A careful study of the Physikalisch Technische Reichsanstalt and of other European laboratories was made in connection with the designing of the laboratory buildings and the selection of the equipment, and many valuable suggestions were derived therefrom. The laboratories have, however, been constructed after American rather than European models, although in their equipment it has been found necessary to draw very heavily upon European instrument makers.

The bureau began its work in temporary quarters and has been developing methods, building and acquiring apparatus and doing testing for the government and the public while the laboratory buildings have been under construction. The larger of the two buildings was only recently completed and the bureau is just now moving into it, the first building having been occupied nearly a year ago. We now find ourselves, about three and a half years from the organization of the bureau, in possession of buildings and equipment costing about $600,000, with a personnel carefully selected through the civil service and numbering altogether seventy-one, maintained by annual appropriations amounting to nearly $200,000, and, judged by the magnitude and importance of the output of testing and investigation, ranking second only to the great German Reichsanstalt among the government laboratories of the world doing this kind of work.

After this brief epitome of the history of the bureau let me state more particularly something of its work and of its rela-

tion to the scientific and technical laboratories of the country.

The work of the bureau may be briefly specified under three separate heads as follows:

1. To acquire and preserve standards of measure and to certify copies of the same, and to test and investigate measuring instruments and to determine the properties of materials.

2. To conduct researches and to investigate and develop methods of measurement; to improve instruments and apparatus for physical measurements and to devise new apparatus, especially for use in testing and in precise measurements.

3. To distribute information regarding instruments and standards to manufacturers, state and city sealers of weights and measures, scientific and technical laboratories, and to any and every one applying for such information.

These three functions of the bureau are closely interdependent. To acquire a standard in some cases involves an elaborate investigation and the independent determination of the value of the standard; and to preserve it may involve subsequent redeterminations of its value to ascertain whether any change has occurred. A new kind of test often involves the investigation of methods of measurement, or the determination of new standards or the construction of a new instrument. Thus research and testing are intimately connected in most of the work of the bureau.

The distribution of information, the third function of the bureau, is accomplished through correspondence and the circulars and bulletins issued by the bureau, and also by the personal visits of people seeking such information.

The three fundamental standards of measure are those of length, mass and time. The oldest of these is the unit of time, the second. This ancient unit has successfully withstood every attempt to replace it by a decimal submultiple of the day. The earth itself is our fundamental timepiece, every revolution upon its axis counting off 86,400 sidereal seconds, from which we immediately derive our standard second. No clock is so perfect a timepiece as the earth and all the standard clocks in the world are corrected by it. What the astronomer does in determining the time by astronomical observations, is to read off the time of day or night by means of a telescope on the starry face of the celestial clock. The telescope corresponds to the hour hand of a 24-hour dial (there is no minute hand), and the stars mark the subdivisions of the dial. The best made clocks of human invention go fast or slow by at least some fraction of a second each day, but there is no proof to show that the terrestrial clock deviates by so much in a thousand years. Thus the unit of time is a natural unit, easily obtained direct from nature and universally employed the world over.

The Bureau of Standards does not intend to make independent time observations, but will correct its standard clocks from the observations made at the neighboring Naval Observatory.

The unit of length has a very different history. The foot has been the most widely used measure of length, both in ancient and in modern times. It was derived, as the name suggests, from the length of the human foot and is thus a natural unit like the second; but, owing to the multiplicity of human feet and their varying dimensions, this unit has varied greatly in different countries and in different ages, its length ranging all the way from the ancient Welsh foot of nine inches to the Piedmont foot of twenty inches. In modern times it has varied from the Spanish foot of less than eleven inches to the Venice foot of over thirteen inches, almost every coun-

try using a foot of different length. The confusion resulting from this lack of uniformity prompted the French in 1799 to adopt a new unit of length, and remembering how surely and elegantly the unit of time is fixed by the rotation of the earth, they sought to make the meter, the new standard of length, permanent and inflexible by basing it upon the dimensions of the earth. The meter was chosen to be one ten-millionth part of the distance from the equator to the pole of the earth at a particular meridian, and was fixed in concrete form as the length of a platinum bar, which has been carefully preserved in Paris. Subsequent and more accurate measurements have given a slightly different value for the circumference of the earth, so that the meter is known not to be, as originally intended, just one ten-millionth of a particular quadrant of the earth. The meter has, however, not been changed, its value being fixed by the length of the platinum standard and not by the earth. Thus the platinum bar has become the primary standard of length, instead of a secondary standard as was originally intended. This is a happy result, for the difficulties of comparing a meter with the dimensions of the earth is too great to make the dimensions of the earth of any value as a standard of length. The original standard meter has been reproduced many times in platinum and iridio-platinum, and many of the civilized nations of the earth possess such duplicates. We have two of them at the bureau of standards in Washington, one of which was recently taken to Paris by Mr. Fischer, and recompared with the standards of the international bureau. The results showed almost perfect agreement with the comparison made fifteen years previously, the difference, if any, being not greater than about 0.5 of a micron, that is, 1/50,000 inch. This is one part in 2,000,000 of the length of the bar and represents about the limit of accuracy obtainable in comparisons of this nature, although the computed probable error of the observations was only .02 of one micron, or less than a millionth of an inch.

The third fundamental unit, that of mass, has likewise varied in different countries and in different ages. The most widely used unit was the pound, and before the metric system came into use there were hundreds of different pounds in use in Europe, differing from country to country and from province to province, and varying also according to the commodity to be measured. The ancient Roman pound was equivalent to a little less than twelve of our avoirdupois ounces, and from it were derived the various Italian pounds, varying in value from the Venice light pound, equivalent to about eleven of our avoirdupois ounces, and the Naples silk-pound and the Milan light pound of about twelve ounces to the Piedmont pound of about thirteen ounces and the Venice heavy pound of about seventeen ounces. There were silk pounds, and chocolate pounds, and table pounds, and goldsmith pounds and medicinal pounds; there were light pounds, and heavy pounds, and half-heavy pounds and extra-heavy pounds. There were pounds of 12, 14, 15, 16, 17, 18, 20, 21, 22, 24, 28, 30 and 36 ounces, and the ounces had varying values in different countries and in different provinces of the same country.

To remedy this distressing confusion the French, in 1799, at the same time the meter was chosen, adopted the kilogram as the unit of mass, fixing it concretely in a cylindrical mass of platinum, which was intended to be equal to the mass of a cubic decimeter of water at the temperature of its maximum density. This, like the meter, was designed to be a natural unit that could be derived originally at any subsequent time and in any country. But, as

in the case of the meter, later determinations showed that the kilogram was not exactly equal to the mass of a cubic decimeter of water as was intended, and hence the platinum secondary standard was adopted as a primary standard of mass and no further attempt made to make it a natural unit. All other countries using the metric system use carefully constructed copies of this original kilogram as their standards of mass. The process of weighing is even more accurate than the comparison of lengths, so that the standard kilograms of the various countries of the world are practically perfect duplicates of the original and of each other.

In 1875 a conference of the representatives of seventeen nations was held in Paris and a permanent international bureau of weights and measures was established and is still maintained. It is located at Sèvres, near Paris, and is supported jointly by the participating nations. Its duties are to care for the fundamental standards of length and mass, to furnish accurately adjusted copies of the same, and to compare standards which may be returned from time to time. Some other testing is done, including the calibration of thermometers. The work is of the highest order of accuracy and leaves little to be desired so far as standards of length and mass are concerned. The metric system has been adopted by nearly all the civilized nations of the world, excepting Great Britain and her colonies and the United States, and is universally used throughout the world for scientific purposes. The electrical units are all based on the metric system and hence electrical engineers employ the metric system almost exclusively, even in this country. The gain to science and commerce due to the adoption of the metric system can scarcely be overestimated and it is to be hoped that it will soon be adopted by the English-speaking countries of the world.

The avoirdupois standard for the United States was defined in 1830 as 7000/5760 of the Troy standard pound of the mint, which in turn was a copy of the British Troy pound, derived from the standard of Queen Elizabeth made in 1588. The latter was derived from the standard of Edward III., and this is said to have come from the city of Troyes, France, hence the name, Troy pound. The metric system was legalized in the United States in 1866, and the meter was declared to be equivalent to 39.37 inches and the kilogram to 2.204 pounds. The international bureau began its work in 1879. The iridio-platinum prototypes of the metric standards were received in this country in 1889. These were so much superior as standards to the brass standard pound and the bronze yard, that in 1893 the metric standards were adopted as fundamental standards by the United States and the pound and yard were defined in terms of them. Thus the metric system is not only legalized in this country, but our fundamental standards are the meter and kilogram and all our weights and measures are derived from these metric standards using the legal equivalents.

Few people, perhaps, realize how needlessly complex our system of weights and measures really is. Instead of a single unit of weight and of length with multiples and submultiples having ratios of ten, and a unit of volume simply related to the unit of length, as is the case in the metric system, we have a multiplicity of units and all kinds of odd ratios for the multiples and submultiples. I beg your indulgence for a moment while I remind you of some of the absurdities of our system. But first recall how much simpler and more convenient our decimal coinage is than the English coinage. Nothing could be simpler than the expression of values in dollars and cents; the use of pounds, shillings and

pence, to say nothing of guineas, crowns and farthings with their odd ratios, being cumbersome in comparison. But our weights and measures are far more cumbersome and complicated than the English coinage. We weigh most merchandise by avoirdupois weight, gold and silver by troy weight, medicines by apothecaries' weight, diamonds by diamond carat weight. We have dry quarts and liquid quarts, long tons and short tons, and a hundredweight is not 100, but 112 pounds. Coal is usually purchased at wholesale by the long ton and retailed by the short ton. A bushel sometimes means 2,150.4 cubic inches and sometimes it means a certain number of pounds weight of a commodity. The American bushel is derived from the old English Winchester bushel, but the legal English bushel of the present day is larger by 69 cubic inches. On the contrary, the English gallon is much larger than the American gallon, the difference amounting to about 20 per cent. We measure wood by the cord, stone by the perch, earth by the cubic yard. Moreover, among the different states of the union are considerable differences in custom and in legal equivalents. We are, of course, much better off than the countries of Europe were a century ago, but the difference is all too small.

Our medieval system of weights and measures is, however, too deeply rooted to be easily displaced. But the metric system is being used in this country more than is generally realized and our rapidly growing foreign trade is bringing it more than ever to the attention of merchants and manufacturers. In England a strong effort is being made to adopt the metric system, with the hope that ultimately a decimal system of currency may also be adopted. The English colonies are even more progressive than the mother country, and strong influences are at work to secure the decimal system throughout the British empire. It will be greatly to the advantage of the United States to keep abreast of this movement, and not to be the last among the civilized nations of the world to throw off the incubus of an incoherent system of weights and measures, whose chief claim lies in the fact that it is in general use.

The testing of lengths and masses constitutes one of the most important branches of the work of the bureau. As I have said, this work has been done by the government for many years, but the facilities for the work are being immensely improved by the bureau so as to extend the range and increase the accuracy of the work. The new laboratories will contain many new balances and comparators and every precaution is being taken to secure the most favorable conditions possible for precision work. When the installation is completed it will probably be the best of the kind in the world.

I have said that the three fundamental units of measure are those of length, mass and time, or the meter, kilogram and second. From these are systematically derived various other units, all forming what is often called the centimeter-gram-second system, or, more briefly, the c.g.s. system. It is not my purpose to enumerate the various derived units which are employed in scientific and technical work, but rather to describe briefly some of those employed in the testing and research work of the bureau. And first let me speak of the work in heat and thermometry. The testing of thermometers is one of the most important branches of the work of the bureau. This work is under the charge of Dr. Chas. W. Waidner, who is personally known to some of you. Dr. Waidner and his assistants have devoted a great deal of effort to the acquisition of reliable standard thermometers and to the investigation of instruments and methods. In this they have

availed themselves of the results of the magnificent work that has been done in this field in Europe, more especially at the Bureau Internationale and the Reichsanstalt, and by the thermometer makers of France and Germany. For our present purpose thermometers may be conveniently grouped as follows: (1) Precision mercury thermometers, to be used as standards or for scientific purposes. They are calibrated very elaborately and are capable of high accuracy. (2) Ordinary mercury thermometers and clinical thermometers. We test clinical thermometers by the thousand and we hope before long that they will come to us by the tens of thousands. Clinical thermometers often change if graduated new, and hence they ought always to be aged, tested and certified to insure their accuracy. (3) High temperature mercury thermometers of hard glass, with nitrogen under pressure above the mercury column, reading up to 550° C. (or about 1000° F.). (4) Platinum resistance thermometers, thermocouples and other forms of pyrometers suitable for measuring furnace temperatures up to 1600° C. (about 2900° F.). Such instruments are used in many manufacturing processes, as well as in research problems and hence are found both in scientific and in technical laboratories. (5) Optical pyrometers for measuring the temperatures of the hottest furnaces and, approximately, even the temperature of the electric arc, the highest temperature attainable by any known means, namely, about 3950° C. (or 7150° F.). An investigation on this subject at the bureau has recently been published by Drs. Waidner and Burgess. (6) Low temperature thermometers, for temperatures below the freezing point of mercury, even down to the temperatures of liquid air and of liquid or solid hydrogen. Such thermometers use pentane or toluene; or a copper-constantan thermocouple is employed. For the very lowest temperatures helium gas is used, helium being the only gas not liquefied at the temperature of solid hydrogen, namely, about 16° above absolute zero, or 257° C. (or 430° F.) below the freezing point of water.

The bureau has done more or less testing in all these lines except the last, but hopes soon to add this to the list of tests which are made.

From the temperature of solid hydrogen to that of the electric arc is a wide range, indeed, and a very considerable equipment of apparatus and machinery is necessary to produce and to measure any temperature throughout this range. For the higher temperatures numerous gas and electric furnaces are required. For the lower temperatures a refrigerating plant and apparatus for liquefying carbon dioxide, air and hydrogen are required. The bureau has recently purchased the low temperature plant which was operated as an exhibit by the British government at the St. Louis Exposition. This was one of the most interesting exhibits of the entire world's fair. Liquid hydrogen was produced in larger quantity by this plant than had ever been done before, more being made and used in public demonstrations during the season than the total amount that has been produced since hydrogen was first liquefied. Solid hydrogen is also produced by the apparatus.

The optical work of the bureau is not so fully established as the work in weights and measures and heat and thermometry, but three well-trained specialists are devoting themselves to it and a fourth is soon to be appointed. The work of research and testing in this section, which has been taken up or is soon to be begun, includes the investigation of the optical properties of instruments and of materials; the application of interference and other optical methods to linear and angular measurements; the investigation of the spectra of

vacuum tubes and other phenomena in connection with the passage of electricity through gases at reduced pressure; and the investigation of questions connected with the polariscopic analysis of sugar and the testing of polariscopes.

The latter subject is of special importance on account of the use of polariscopes in determining the duty on sugar imported into the United States. The bureau has undertaken, at the request of the Treasury Department, to supervise the work of polariscopic analysis of sugar in all the customhouses of the country. Sugar is the chief source of revenue among articles imported, the duties collected by the government amounting to over $60,000,000 per annum. The duty on each importation is determined by the angle through which a beam of polarized light is rotated when passed through a solution of a sample of sugar, the percentage of pure sugar being shown by a specially prepared table when the angle of rotation has been determined. For some years a difference has existed between the experts of the government and those employed by the sugar interests as to the effect of temperature upon the indications of the polariscope, and although the difference is only a fraction of one per cent., it amounts to a large sum when applied to the hundreds of millions of dollars paid in duty during the last few years. The question is being contested in the courts and in the meantime the bureau is making some careful investigations on the subject in the interest of the government.

Another line of the bureau's work not yet fully established is the testing of gas and water meters, pressure gauges and manometers for high and low pressures, engine indicators and the determination of the strengths of materials including cements and other building materials. This will probably develop into a very important branch of our work, in which we can be of much service to scientific and technical laboratories, as well as to the government and the public.

The official testing of scales, measures of length and volume, gas, water and electricity meters and other instruments by which the commodities purchased by the people are measured is not done in this country as thoroughly as it ought to be. In very few cities do the sealers of weights and measures go about systematically testing the instruments employed for measuring merchandise. England surpasses us in looking after the interests of the people in this particular. One of the functions of the bureau is to educate the public to the importance of this work. A step in this direction is the national convention of sealers of weights and measures to meet next month in Washington in response to a call issued by the bureau of standards.

The various lines of testing and research which have so far been mentioned, namely, weights and measures, heat and thermometry, light and optical instruments, and engineering instruments, are included in the first division of the work of the bureau of standards. The second division includes electricity and photometry. In the early days of its development electricity was essentially a qualitative science; its modern history has seen it become distinctly quantitative, and its wonderful development has been largely, if not mainly, due to the use of measuring instruments in studying and applying it. The three fundamental units of measure are the ohm, the unit of resistance; the ampere, the unit of current; and the volt, the unit of electromotive force. These are so related by Ohm's law that when two are defined the third becomes fixed and can be determined by the use of the other two. These units are not arbitrarily chosen, but are determined by experimental investigation. Their magnitudes depend upon the fundamental units

of length, mass and time, and these having been selected (namely, the centimeter, gram and second), the definitions or specifications of the electrical units follow logically, but their concrete expression in actual standards that can be employed in electrical measurements can only be attained after most painstaking researches in what are called absolute measurements. The two of these three units which have been so determined are the ohm and the ampere. As all other electrical units are based upon these, it is of the greatest importance that they be determined with the utmost exactness. At the International Electrical Congress at Chicago, in 1893, they were redefined in accordance with the results of the best determinations made up to that time. The ohm is specified in terms of the resistance of a column of mercury 106.3 cm. long, having a cross-section of one square millimeter; the ampere in terms of the quantity of pure silver it will deposit electrolytically per second from a solution; the volt in terms of the electromotive force of the standard Clark cell. An immense amount of work has been done by numerous investigators in various countries of the world in the determination of the values of these electrical units, and the figures adopted in the definitions undoubtedly come very near the truth. Nevertheless, we know from subsequent work that at least two of these units are very slightly in error, and one of the most important problems before the bureau of standards is the redetermination of these fundamental units. The error in question is small, so small as to be of no consequence in engineering and commercial work. But scientifically it is important, and as instruments and methods are improved year by year, any small discrepancies in our fundamental units become of more and more significance. The National Physical Laboratory of England, the Physikalisch-Technische Reichsanstalt of Germany and the National Bureau of Standards, as well as a few private investigators in this country and abroad, are all working in the same direction. The recent International Electrical Congress at St. Louis provided for the formation of an international commission, whose function it shall be to foster and in some degree direct and coordinate researches of this character. This commission will probably organize and enter upon its work during the coming year. The difficulties to be overcome are so great that only the most elaborate researches carried out under the most favorable circumstances can be expected to bring us appreciably nearer the desired goal. Two researches at the bureau of standards during the past year gave results of value preparatory to the redetermination of the ampere in absolute measure. One was by Dr. Wolff, showing how to overcome one of the defects of the standard cell; a new method of preparing the mercurous sulphate yielding a crystalline product which gives cells of more uniform electromotive force than formerly. Professor Carhart, of Ann Arbor, who has been engaged upon this subject for some time, arrived independently at the same result even earlier, the results being announced by both men at the same meeting in Washington in April last. The other investigation was by Dr. Guthe, who, after carefully studying all the various forms of silver voltameters which have been proposed, showed that although different kinds gave slightly different results, certain ones when properly handled, gave practically identical results, and hence could be depended upon for measuring current to a very high order of accuracy. Dr. Wolff is continuing his work on standard cells and Dr. Guthe is now engaged in the absolute measurement of current, by means of a new electrodynamometer.

I have been engaged, with the assistance of Mr. Grover, Dr. Lloyd and several other members of the bureau, in the absolute measurement of electric capacity and inductance and in the investigation of electrical measuring instruments, more especially for the precise measurement of alternating current, voltage and energy. These investigations have involved the construction of much new apparatus, as well as the thorough study of some well-known instruments. One of the practical problems in connection with the accurate measurement of capacity or inductance is the determination of the frequency of the interrupter or of the alternating current employed. This usually amounts to obtaining the speed of some kind of motor, often an electric motor. For some kinds of work, to be within one per cent. is considered sufficiently accurate. For other cases one tenth of one per cent. is none too good. In still others one hundredth of one per cent. is deemed necessary. In this work we sought to get the frequency to a thousandth part of one per cent. This required a very perfect control of the speed, and yet by attention to all the sources of disturbances, and by the use of a very sensitive indicator, the desired result was obtained and an important additional step taken in absolute measurements.

Many other interesting and important questions are being investigated, and work enough for years is already before us. These particular examples of the work at the bureau have been cited, not because I presume that you are especially interested in the problems themselves, but rather to illustrate the kind of research work we are doing.

The work of testing is being carried on at the same time. Resistance standards, current standards, standard cells, wheatstone bridges, potentiometers, magnetic instruments, current instruments, voltmeters, wattmeters, condensers, inductances and many other electrical instruments have come to us from manufacturers, universities, technical laboratories and departments of the national government. To be able to get reliable standards and to have instruments calibrated at a nominal cost is a boon to all careful experimentalists. Heretofore it has often happened that the burden of the work in a given investigation has been to calibrate the instruments employed, and often the facilities at command were insufficient to yield results of high accuracy. Within the last three years (that is, since the bureau has been testing instruments) there has been a marked improvement in the quality of some kinds of electrical instruments made in this country. It is now so easy to determine whether a resistance box guaranteed by the maker to be correct to one fiftieth of one per cent. fulfils the guarantee, that the maker is compelled to use correct standards and to adjust his resistances carefully in accordance with the same.

Probably the most interesting collection at the St. Louis Exposition from the standpoint of physical science was the magnificent exhibit of scientific instruments made by Germany. There was a time not so very long ago when France and England surpassed Germany in the production of scientific instruments. But the giant strides which Germany has made in the last twenty years has left other countries in the rear, and this wonderful progress has been largely due to the wise encouragement and assistance offered to instrument makers by the German government. This assistance has taken various forms, but the principal factor has probably been the work of the Reichsanstalt and the Normal Aichungs Kommission, the two government laboratories doing the work which the bureau of standards aims to do in the United States. They have set a high standard for

scientific instruments, and have not only shown how defects could be corrected, but have developed the theory and the design of many new instruments. All this has occurred so recently that it is not generally known in the United States, and German instruments are not as largely used as they deserve to be. We hope that the next few years may witness a similar impetus in the production of scientific instruments in this country, and that the United States may come to hold the same enviable position with respect to scientific instruments in general that she now does with respect to tools and labor-saving machinery and to certain special classes of scientific instruments.

The advantage of having instruments and standards of high accuracy for engineering and research work is obvious and needs no proof. I wish, however, to point out the advantage of using such instruments as far as practicable for purposes of instruction, especially in the more advanced laboratory courses. If the apparatus is not accurately adjusted the careful student and, perhaps, his instructor as well, is prone to lose valuable time in trying to locate errors that are inherent in the apparatus, or in striving for a degree of accuracy which is unattainable with the instruments employed. On the other hand, when the apparatus is known not to be correct it is so easy to attribute to the instruments any discrepancies in the results that careless reading and hasty work may possibly be encouraged. It is a great delight to the real lover of quantitative experimental work, of whom a great many are to be found in almost any college class, to do a piece of work with precision instruments and obtain an accurate result, duly checked by proper variations of the experiment. The educational value of such work is certainly greater than when only roughly done; the pleasure derived is incomparably greater. It is by no means necessary that all the instruments of a laboratory be sent away to be tested. If only the laboratory possesses correct standards and suitable comparing apparatus, the calibration or adjustment of most of the other instruments furnishes excellent experimental work for the students and assistants of the laboratory.

Another important section of the work of the bureau is photometry. This is really optical rather than electrical, but owing to the fact that the chief work is with electric lamps and a very considerable electrical equipment is required, it is grouped with the electrical in our organization. The standards employed in photometric testing are less satisfactory than in most other branches of physical measurements. The quantity of light emitted by a given source is usually expressed in candle power; the ordinary incandescent electric lamp, being approximately equivalent to sixteen standard candles, is called a sixteen candle-power lamp. The candle as a standard of measure has passed out of vogue, but light is still expressed in candle power. Various sources of light have been proposed as standards, the Hefner lamp burning amyl-acetate, being most used as a primary standard. As working standards specially prepared incandescent lamps are generally used, and are quite satisfactory. Greater progress has been made in recent years in developing photometers and the auxiliary apparatus for comparing lamps than in perfecting a primary standard of illumination. Although the initial equipment of the bureau for this work is not yet complete, we have already done considerable testing, especially in rating lamps to be used as standards by manufacturers and others, and in testing lamps purchased by the various departments of the government. Millions of incandescent lamps are sold each year on carefully drawn specifi-

cations, and it is a matter of considerable importance to know whether the conditions of the contracts are met by the manufacturers.

In addition to the exhibit made by the bureau of standards in the government building at the St. Louis exposition, an electrical laboratory was equipped and maintained in the electricity building. This was done at the request of the exposition management, the object being twofold; first to exhibit a working electrical laboratory, and, second, to do electrical testing for the jury of awards, for the railway test commission, and other electrical interests at the fair. The laboratory building, which was within the palace of electricity, and extended along one of its walls for a distance of about 175 feet, was divided into six rooms. Notwithstanding the fact that it was a temporary structure the laboratory possessed many of the appointments of a permanent installation; and, although many disadvantages and limitations were experienced in doing scientific work amid such surroundings, we succeeded in doing a good deal of satisfactory work, including both research and testing. So complete a laboratory has never been installed in any previous world's fair, and it proved to be of considerable interest both to visitors and to those electrical interests which availed themselves of its facilities for testing instruments. A refrigerating machine, installed adjacent to the laboratory as an exhibit, furnished refrigeration for experimental purposes and also for controlling the temperature and reducing the humidity of the atmosphere within the laboratory. This proved not only a great convenience in doing experimental work, but also a comfort to the workers, and the cool office of the bureau was a favorite retreat for the electrical jury in the hottest days of the jury period.

The third division of the work of the bureau is the chemical division, in charge of Professor W. A. Noyes. The development of this work has waited on the completion of our laboratory buildings. The installation of the equipment of the chemical laboratory is, however, now in progress and chemical work will be well under way before the end of the present fiscal year. The work in chemistry will consist in part in cooperating in certain lines of physical research, and in part in serving the chemical interests of the country. This will be done partly by research and partly by testing.

The bureau has already done considerable testing of apparatus used in volumetric analysis. The American Chemical Society, through its committee, has been cooperating with the bureau in fixing the limits of tolerance for such apparatus and in defining the specifications to be followed by the manufacturers. Another committee of the American Chemical Society has proposed a plan whereby standards of purity of chemical reagents shall be set, after careful investigation of the subject, and specific labels selected to indicate definite degrees of purity of such reagents. The bureau of standards, according to this plan, is to cooperate with the society in securing conformity to these standards on the part of manufacturers. I will not undertake to give details of the proposition; the work is of great importance and promises to bring the bureau of standards into close relations with the manufacturing and analytical chemists of the country. Another subject in which the bureau has been invited to cooperate with the American Chemical Society is in the matter of securing uniformity in technical analyses. Too great discrepancies are found in the results obtained by different public and other chemists when analyzing portions of the same sample. This is largely due to the different methods of analysis.

It is proposed to investigate thoroughly the various methods employed, and to select certain of the best as standard, with the expectation that, using the best reagents, the results found by different analyses may be more concordant and more accurate. Other lines of research and testing are contemplated, and will be undertaken as the facilities permit.

The field of chemistry, as well as physics, has so expanded in recent years that the two now overlap over large areas. Indeed, it is often impossible to say that a given problem belongs to one or the other, the fact being that it pertains to both fields. Hence, the physicist frequently comes to the point where he needs the resources of a chemical laboratory to carry him through a problem supposed to be purely physical, and conversely the chemist, not only in electro-chemistry and physical chemistry, but in analytical chemistry as well, requires very many of the facilities of a well-equipped physical laboratory. Hence we have so planned our laboratories that all the facilities of the entire equipment may be brought into service on any problem, whether it originates on the physical side or on the chemical. This we believe will prove of great advantage to the work of the bureau.

There are three chemists in the chemical division at present and the number will be increased as the work develops.

It is the aim of the bureau not only to conduct investigations through its members, but also to afford facilities for research by others who may come as scientific guests. It often happens that a proposed investigation requires apparatus or other facilities not at the command of the person proposing the investigation, and no university can, perhaps, offer him the necessary facilities and assistance. The bureau of standards hopes to encourage investigation by providing such facilities and assistance, but can do so only to a limited degree until the laboratory space is increased by additional buildings. There are scores and perhaps hundreds of ambitious physicists, young and old, engaged in teaching in the colleges and technical schools of the country who are deterred from doing valuable research work by lack of facilities and assistance. It is believed that a generous policy of assistance through the bureau of standards will be greatly appreciated by such workers, and that the output of original research from America will be materially increased thereby. A summer's work under favorable circumstances might yield as much as a full year's effort under adverse conditions, and a year, enough to amply repay the sacrifice it might involve. But, as I have already said, the full realization of this plan lies in the future. For the present all our laboratory space is required to meet our own pressing needs, although we do have just now one scientific guest with us, about to begin some interesting investigations.

I have tried to show briefly some of the work which the bureau of standards is doing and is preparing to do, to fulfill its functions as the American National Physical Laboratory, using the word physical in a liberal sense, as its work includes both chemistry and engineering. The national government is doing a large amount of scientific work, through the various bureaus and departments. That money expended in this direction is well invested, the Department of Agriculture, the Coast and Geodetic Survey, the Geological Survey and other bureaus have already abundantly proved. Their function and ours is to contribute something to the advancement of human knowledge and to serve the public. We hope not only to be of service to scientific and technical laboratories in the various ways I have tried to explain, but

also to serve in many ways the larger general public.

It is a peculiar pleasure to me to be present to-day at the dedication of the John Bell Scott Physical Laboratory. It is a beautiful building, a fit representative of the splendid science to which it is dedicated; a notable addition to the equipment of Wesleyan, testifying eloquently to the generosity and loyalty of the donors; a worthy memorial to the unselfish life of the noble young man after whom it is named. The good it will do in the future years is immeasurable.

Edward B. Rosa.
National Bureau of Standards.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. SECTION A, MATHEMATICS AND ASTRONOMY.

Vice-President—Professor Alexander Ziwet, University of Michigan, Ann Arbor, Michigan.

Secretary—Professor Laenas G. Weld, University of Iowa, Iowa City, Iowa.

Member of the Council—Professor J. R. Eastman.

Sectional Committee—Superintendent O. H. Tittmann, Vice-President, 1904; Professor Alexander Ziwet, Vice-President, 1905; Professor L. G. Weld, Secretary, 1904–1908; Dr. J. A. Brashear, one year; Professor J. R. Eastman, two years; Professor Ormond Stone, three years; Professor E. B. Frost, four years; Professor E. O. Lovett, five years.

Member of the General Committee—Professor G. B. Halsted.

Press Secretary—Professor J. F. Hayford.

Dr. W. S. Eichelberger, of the U. S. Naval Observatory, was elected vice-president for the next meeting.

The Astronomical and Astrophysical Society of America met in affiliation with Section A, the two organizations holding alternate sessions on December 28, 29 and 30.

The vice-presidential program was presented on the afternoon of Wednesday, December 28. In accordance with the recommendations of the Committee on the Policy of the Association this program was given a broader scope than heretofore and included the address of the retiring vice-president, Superintendent O. H. Tittmann, upon the subject 'The Present State of Geodesy,' and a paper by Professor Josiah Royce, of Harvard University, entitled 'Symmetrical and Unsymmetrical Relations in the Exact Sciences.' The former of these has been published in Science for January 13, and the latter will appear in an early number of the same journal.

The following papers were presented at the regular meetings of the section:

Synchronous Variations in Solar and Meteorological Phenomena: Mr. H. W. Clough, U. S. Weather Bureau, Washington, D. C.

The portion of the paper relating to meteorological phenomena is essentially an extension of Professor Brückner's researches on the 35-year cycle of variation in terrestrial climates. Definite epochs have been assigned for the variations of the several meteorological elements and the results of Brückner have been supplemented by investigations of various minor meteorological relations and the prices of grain. The probable value of the period length is found to be 36.2 years, instead of 34.8 years, Brückner having used in calculating the latter value an extra oscillation in the sixteenth century, which should be regarded as a secondary variation. Brückner traced the cycle as far back as 1000 A. D. by means of historical accounts of several winters. Comparison of the epochs in different latitudes discloses an apparent retardation in low latitudes. This may indicate that the influence efficient in producing these variations is experienced mainly in high latitudes. Periods of excessive precipitation follow by about five years those of deficient tem-

perature. These cold, wet periods are characterized by a more rapid atmospheric circulation and a lower average latitude of storm tracks. Investigation of grain prices in England from about 1265 shows variations in a cycle of 36 years, high prices corresponding with cold, wet periods.

Wolfer's epochs of maximum and minimum sunspots from 1610 show that the so-called 11-year period is a variable interval, ranging from 8 to 16 years. These varying intervals have a periodicity of about 36 years and it is found that periods during which the sunspot interval is at a minimum are characterized by maximum sunspot and auroral manifestations. This 36-year cycle in solar phenomena has been traced back to about 1000 A. D. by utilizing the 'probable maxima' of Fritz. The sun may, therefore, be regarded as a variable star, whose mean period of variation undergoes a cyclical variation in length.

Comparing the solar and meteorological epochs in the 36-year cycle from 1050 to 1900, the epochs of maximum solar activity, as evidenced by a decreased length of the sunspot period, are shown to precede the epochs of low terrestrial temperatures by from seven to ten years.

A long-period variation of about 300 years is shown by variations in solar spottedness, in the ratio $a : b$, and in the length of the 36-year cycle; the ratio $a : b$ and the length of the cycle decreasing with increasing solar activity. This cycle of 300 years is traced in solar variations during the past thousand years and is also apparent in meteorological variations, as shown by the records of the time of vintage of Dijon, France, since 1400.

Tables showing solar and meteorological epochs were exhibited.

Temperature Corrections of the Zenith Telescope Micrometer, Flower Astronomical Observatory: Professor C. L. DOOLITTLE, University of Pennsylvania.

Results from Observations of the Sun, Moon and Planets for 26 Years: Professor J. R. EASTMAN, Andover, N. H.

The only continuous and complete set of observations of the sun, moon and planets, in this country, was made at the Naval Observatory from January, 1866, to June 30, 1891. This work was continuous with the observations of the standard and miscellaneous stars, and most of the results were found to be affected by the same errors that modified the results for the stars, and also by errors peculiar to observations of bodies presenting in the telescope large disks, like those of the sun and the moon, smaller ones like those of major and minor planets. The errors pertaining to the stars were discussed in the introduction to the 'Second Washington Catalogue of Stars'; and more in detail in a paper read at the last Boston meeting of this association.

The second class of errors mentioned above was considered and it was shown that there is a high probability of the presence of peculiar errors in solar, lunar and planetary observations with all large instruments where measures are made of both coordinates.

Determination of the Solar Rotation Period from Flocculi Positions: Mr. PHILIP FOX, Yerkes Observatory, Williams Bay, Wis.

This determination is based upon measurements of flocculi positions on spectroheliograms obtained at the Kenwood Observatory during the spot-maximum of 1892–'93–'94. The method of measurement devised by Mr. Hale, that of projecting the plate upon a globe whose surface is ruled in degrees of longitude and latitude, proved to be accurate and rapid. Motions for proper orientation of the image upon the globe were provided. The results obtained from measurements of about 1,000 points have been grouped in zones 5 wide and are exhibited in the following table:

0 to 5	24.56 days.
5 to 10	24.79 "
10 to 15	25.03 "
15 to 20	25.26 "
20 to 25	25.45 "
25 to 30	25.99 "
30 to 35	25.31 "

Determination of all Non-divisible Groups of Order $p^m \cdot q$ which Contain an Abelian Subgroup of Order p^m and Type [1, 1, 1 ⋯ to m units]: Mr. O. E. Glenn, University of Pennsylvania, Philadelphia.

Burnside remarks, at the beginning of Chapter XV. of his 'Theory of Groups,' that the most general problem of finite group theory is the determination and analysis of all distinct types of groups whose order is a given integer. The author suggests as a more comprehensive problem the *generalization* of all types belonging to a given integer. In the paper is given a determination of the sets of defining relations which include as special cases all groups of order pq, p^2q, and a family of the known groups of order p^3q.

When q is a proper divisor of $p^m - 1$, G is defined by the relations

$$P_i^p = Q^q = 1, \quad P_iP_j = P_jP_i, \quad Q^{-1}P_kQ = P_{k+1}$$
$$(i=1, 2, \ldots, m;\ j=1, 2, \ldots, m;\ k=1, 2, \ldots, m-1.)$$

$$Q^{-1}P_mQ = P_1^{(-1)^{m-1}} P_2^{(-1)^{m-2}\Sigma(\lambda\lambda^p \ldots \lambda^{p^{m-2}})} \ldots P_{m-1}^{-\Sigma(\lambda\lambda^p)} P_m^{\Sigma(\lambda)},$$

λ being a mark of the $G \cdot F(p^m)$ and a primitive root in that field of the congruence

$$\lambda^q \equiv 1 (\mathrm{mod}\ p).$$

In case $p \equiv 1$ (mod. q) the group is defined by

$$P^{ip} = Q^q = 1,\ P_iP_j = P_jP_i,\ Q^{-1}P_iQ = P_i^{a^{x_i}}(x_1 = 1),$$
$$a^q \equiv 1 (\mathrm{mod.}\ p).$$

The first set of relations represents a single type. The number of types in the second set is given by

$$N = \frac{1}{m}\left[\sum_{\sigma=1}^{(m-1)(q-1)} P(0, 1, 2, \cdots, q-2)^{m-1}\sigma - \psi\right],$$

P being Cayley's form of the partition symbol and ψ a determinate function of m and q.

A Note on Groups of Order 2^m which Contain Self-conjugate Groups of Order 2^{m-2}: Dr. G. H. Hallett, University of Pennsylvania, Philadelphia.

In the list of groups of the character indicated above which is given in Burnside's 'Theory of Groups,' there are six types. There appears to be a simple type of group which is non-isomorphic to any one of these six groups. The object of the paper is to set up the defining relations of this type, viz.,

$$P^{2^{m-2}} = 1, \qquad Q^4 = P^{2^{m-3}}, \qquad Q^{-1}PQ = P^{-1}.$$

Biology and Mathematics: Professor G. B. Halsted, Kenyon College, Gambier, O.

In Professor Halsted's paper attention was called to certain analogies which have been assumed to exist between the mathematical doctrine of continuity and the evolution of new species through natural selection. He then proceeded to show that the analogy between mathematics and biology is much closer if we emphasize, on the one hand, the idea of discontinuity as it appears in modern mathematics and, on the other, those phases of the process of evolution supposed to be more readily explained by the theory of mutations.

The Path of the Shadow of a Plummet Bead: Professor Ellen Hayes, Wellesley College, Wellesley, Mass.

The equation to the path of the shadow of a plummet bead was derived, and discussed for various latitudes and for different seasons of the year.

The interest and value which this gnomon conic possesses as an observation exercise for beginners in elementary practical astronomy were made apparent.

The Computation of the Deflections of the Vertical due to the Topography Surrounding the Station: Professor J. F. HAYFORD, Coast and Geodetic Survey, Washington, D. C.

The computation of deflections of the vertical depending upon the topography surrounding a station is of fundamental importance in connection with new investigations of the figure of the earth. Such computations have been available in but few cases because of the difficulty of making them. The method now in use by the Coast and Geodetic Survey was fully shown. Such computations by this method have already been made at 250 astronomical stations in the United States, in each of which account is taken of the topography within a circle surrounding the station having a radius of more than 2,500 miles.

Extension of a Theorem due to Sylow: Professor G. A. MILLER, Stanford University, Cal.

Every group G of order p^m, p being any prime number, contains at least p invariant operators. This fundamental theorem, due to Sylow, is included in the following:

Every non-abelian group of order p^m contains at least p invariant commutator operators, and its commutator quotient group is always non-cyclic. The paper is devoted to a proof of this theorem and the following closely related theorems:

It is possible to construct a non-abelian group having any arbitrary abelian group as a commutator quotient group.

Every non-cyclic abelian group of order p^a is the commutator quotient group of some non-abelian group of order p^m.

On Inversions: Professor J. J. QUINN, Warren, Pa.

Mr. Quinn exhibited and explained a number of new linkages for describing the right line, in each of which the principle of inversion was applied.

On Systematic Errors in Determining Variations of Latitude: Mr. FRANK SCHLESINGER, Yerkes Observatory, Williams Bay, Wis.

Observations for the variation of latitude seem to be subject to certain systematic errors. In this paper two contemporaneous series made near Honolulu in 1891 and 1892 are discussed and compared. The method of separating the systematic errors common to both series from the accidental is indicated, the conclusion being that there is present some source of error common to both observers and therefore probably beyond their control. This result is shown to be independent of any assumption regarding the variation of latitude during the period under discussion..

Some Experiments on the Distortion of Photographic Films: Mr. FRANK SCHLESINGER, Yerkes Observatory, Williams Bay, Wis. Read by title.

Bibliography and Classification of Mathematical and Astronomical Literature at the Library of Congress: Mr. J. D. THOMPSON, Library of Congress, Washington, D. C.

Attention was called to the printed cards issued by the Library of Congress for books and pamphlets on mathematics and astronomy in its collection and it was explained how these may be used to great advantage in the special libraries of the mathematical departments of universities and of observatories. The classification scheme used at the Library of Congress was also explained. This paper will be printed by the Library of Congress.

On an Optical Method of Radial Adjustment of the Axes of the Trucks of a Large Observatory Dome: Professor DAVID TODD, Director Amherst College Observatory, Amherst, Mass.

The larger dome of the new observatory of Amherst College is mounted on fourteen

trucks, fitted with twin rings of double ball bearings of the Chapman type. The treads of the wheels are coned to the exact angle which will make their apexes all coincide with the point at the center of the plane of the circular trucks. Ease of revolution of the dome depends very largely upon the accuracy with which this adjustment is made and maintained. The necessary condition has been secured by attaching a small galvanometer mirror to the axis of each truck, and adjusting it normally. A theodolite mounted at the center of the dome then gave the reflections of its objective exactly centered on the cross wires, when the axis of the truck was brought to the proper direction.

An Exhibition of a New Form of Frame for Straight Line Mathematical Models: Professor C. A. Waldo, Purdue University, Lafayette, Ind.

A new form of thread model for ruled surfaces was exhibited by Professor Waldo, the frame for the model being conformed to the surface of a sphere, thus permitting location of the points of attachment of the threads with much greater ease than in the ordinary forms in which the limiting surface is discontinuous. The method of construction was also explained.

The Application of Mayer's Formula to the Determination of the Errors of the Equatorial: Professor L. G. Weld, State University of Iowa, Iowa City, Ia.

Let the polar axis of the equatorial be rigidly clamped with the telescope first to the east and then to the west of the pier and the transits of three stars observed in each of these positions of the instrument. The clock correction being assumed known, the errors of azimuth, level (of declination axis) and collimation (in right ascension) may be obtained for each position by the use of Mayer's formula. From the two sets of errors thus made known the mean azimuth error of the polar axis and the angle between this axis and the declination axis may be determined. The method is independent of the accuracy of the hour circle and may be used in correcting the setting of this circle upon the polar axis. When the hour circle is delicately graduated the data may also be used to determine the flexure of the declination axis.

Laenas Gifford Weld,
Secretary.

*ALBATROSS EXPEDITION TO THE EASTERN PACIFIC.**

The *Albatross*, under command of Lieut.-Commander L. M. Garrett, left San Francisco on the sixth of October and arrived at Panama on the twenty-second. I am fortunate in having as assistant for this trip Professor C. A. Kofoid, who has had great experience in studying the protozoa both in fresh water and at sea; he has been given charge of the collection of radiolarians and diatoms and of other minute pelagic organisms; and he will prepare a report on the results of that branch of the expedition. On the way along the coast Professor Kofoid took advantage of the opportunity for making surface hauls with the tow nets as well as vertical hauls, generally to a depth of 300 fathoms. A large amount of pelagic material was thus collected, not at a great distance from the coast, however. Off Mariato Point the *Albatross* made two hauls in the vicinity of the stations where in 1891 she found 'modern green sand,' in about 500 and 700 fathoms. It was interesting to find the green sand again, as the specimens collected in 1891 were lost in transit to Washington.

Immediately on reaching Panama the vessel was coaled and provisioned. On my

* Extract from a letter of Mr. Alexander Agassiz to Hon. George M. Bowers, U. S. Fish Commissioner, dated Lima, November 28, 1904.

arrival there on the first of November I found her ready for sea, and on the second we left for Mariato Point to make a few additional trawl hauls in the region of the green sand. In both the hauls made off Mariato Point green sand was found, but not in the quantity obtained in 1891.

From Mariato Point we made a straight line of soundings towards Chatham Island in the Galapagos, intersecting the ring of soundings we made northeast of the islands in 1891. The deepest point of the line (1,900 fathoms) was found about 100 miles southwest of Mariato Point. The bottom then continued to show about 1,700 fathoms for nearly 200 miles and then shoaled very gradually to 1,418 fathoms about 80 miles from Chatham Island. From there it sloped quite rapidly, the 1,000-fathom line being not more than 60 miles from Chatham Island. We ran a short line south of Hood Island and found a somewhat steeper slope to that face of the Galapagos, reaching over 1,700 fathoms in a distance of less than 50 miles; the bottom then remained comparatively flat, attaining a depth of 2,000 fathoms about 100 miles further south. This depth we carried eastward on a line to Aguja Point; about half way the soundings had increased to over 2,200 fathoms, and remained at about that depth to within 60 miles of the coast, when the depth rapidly shoaled. From Aguja Point we ran a line of soundings to the southwest to a point about 675 miles west of Callao; on this line the depths gradually increased from 2,200 fathoms, 100 miles off the point, to nearly 2,500 fathoms. On running east to Callao the depth soon increased to about 2,600 fathoms, and at a distance of about 80 miles off Callao we dropped into the Milne-Edwards Deep and found a depth of over 3,200 fathoms. We spent a couple of days in developing this deep, making soundings of 1,490, 2,845, 458, 1,949, 2,338 and 3,120 fathoms; showing a great irregularity of the bottom within a comparatively limited area of less than sixty miles in diameter. Thus far all our soundings have been made with the Lucas sounding machine.

In the Panamic Basin to the northeast of the Galapagos we trawled only off Mariato Point, but we occupied ten stations with the tow nets, hauling both at the surface and at 300 fathoms, and vertically from that depth; we also continued this pelagic work at nearly all the stations (35) from the Galapagos to Callao.

When off Chatham Island we began to trawl, and used the tow nets regularly, occupying 20 stations. The nets were in charge of Mr. F. M. Chamberlain. The pelagic collections, as a whole, are remarkably rich. They are especially noteworthy for the great variety and number of pelagic fishes obtained inside the 300-fathom line at a considerable distance from shore, from 300 to 650 miles. Many of these fishes had been considered as true deep-sea fishes, to be obtained only in the trawl when dredging between 1,000 and 1,500 fathoms or more. On one occasion the tow net brought up from 300 fathoms, the depth being 1,752 fathoms, no less than 12 species of fishes; of some species of *Myctophum* we obtained 18 specimens, of another 37, of a third 45; in all nearly 150 specimens. On other occasions it was not uncommon to obtain 8 or 10 species, and from 50 to 100 specimens. Among the most interesting types obtained in the tow net I may mention as coming from less than 300 fathoms *Stylophthalmus* and *Dissomma*, both of which Chun considers as deep-sea fishes, found in depths of 600 to 4,000 meters; also a species of *Eurypharynx* obtained for the first time in the Pacific. *Stylophthalmus* I had also caught in the tow net in 1900, during the tropical Pacific expedition of the *Albatross*, in depths of less than 300 fathoms. In the lines we ran across the

great northerly current which sweeps along the coasts of Peru and Chili and is deflected westward at the easterly corner of the Galapagos Islands, we obtained with the tow nets an unusually rich pelagic fauna at depths less than 300 fathoms. We collected a number of schizopods, among them many beautifully colored Gnatheuphausiæ, pelagic macrurans; huge, brilliant red copepods, as well as many other species of blue, gray, mottled and banded copepods. *Lucifer* and *Sergestes* were abundant in many of our hauls. Many species of amphipods were collected, hyperids without number, especially where the surface hauls were made among masses of Salpæ, which, on several occasions, formed a jelly of tunicates. Several species of Phronimæ also occurred constantly in the tow nets. Sagittæ were very numerous, a large orange species being noteworthy. Several species of *Tomopteris*, some of large size and brilliantly colored, violet or carmine with yellow flappers, and two species of pelagonemerteans, were taken. Two species of orange-colored ostracods were also common, one having a carapace with a long spiny appendage. We obtained several species of pelagic cephalopods, *Cranchia* and *Taonius* among them. Two species of *Doliolum* also occurred, but they were never as abundant as the Salpæ, two species of which often constituted the whole contents of the net.

In the surface and deeper tows we procured a number of acalephs. We have thus far collected more than 50 species of medusæ and siphonophores, many of which have been figured by Mr. Bigelow, differing from those of the 1891 expedition. Atollæ and other deep-sea medusæ were common within the 300-fathom line.

The Salpæ guts gave us, in addition to the finer tow nets, immense collections of radiolarians, diatoms and Dinoflagellata, many of which have been considered to live at great depth and upon the bottom. The number of diatoms found in this tropical region is most interesting. They have usually been considered as characteristic of more temperate and colder regions. On several occasions the surface waters were greatly discolored by their presence, and the extent of their influence on the bottom deposits is shown by the discovery of a number of localities where the bottom samples at depths from 1,490 to 2,845 fathoms in the track of the great Peruvian current formed a true infusorial earth.

The tow nets also contained many species of *Hyalea, Cymbulium, Styliolus, Cleodora, Tiedemannia, Clio* and the like. On one occasion the mass of the pelagic hauls consisted entirely of small brown copepods, the contents of the tow nets looking like sago soup. Another time Sagittæ, Salpæ, *Doliolum* and *Liriope*, all most transparent forms, formed the bulk of the tow net's catch. Still another time, *Firoloides* and *Carinaria* constituted the bulk of the haul. These catches, coming on successive days or interrupted with hauls of more than mediocre quality, show how hopeless it is at sea to make any quantitative analysis of the pelagic fauna and flora at any one station within the influence of such a great oceanic current as the Chili and Peruvian stream.

Hauls of the trawl made at the western extremity of our lines brought us within the area of the manganese nodules, with its radiolarian ooze mud, cetacean earbones and beaks of cephalopods; nothing could stand the damaging action of these nodules in grinding to pieces all the animal life the trawl may have obtained. Down to the depth of 2,200 fathoms or so the bottom was constituted of globigerina ooze, its character being more or less hidden when near the coast by the amount of detrital matter and terrigenous deposits which have drifted out to sea.

North of the Galapagos we found vegetable matter at nearly all the stations, and between the Galapagos and Callao such material was not uncommon in the trawl.

Beyond the line of 2,200 fathoms dead radiolarians became quite abundant on the bottom, as well as in the mud of the manganese nodules, though among the nodules it was not uncommon to find an occasional *Biloculina*. Many of the dead radiolarians obtained on the bottom Mr. Kofoid found in the guts of Salpæ swimming near the surface or within the 300-fathom line in the tow nets sent to that depth. The same is the case with many of the Dinoflagellata which have been considered as deep-sea types. In our tow nets from 300 fathoms we found very commonly *Tuscarora, Tuscarosa, Aulospira* and others. In depths of 300 fathoms to the surface the tow net was rich in Tintinnidæ, either dead or moribund Planktionellæ, and Dinoflagellata. Among the Dinoflagellata there were 10 species of *Ceratium*, 9 of Peridinidæ, *Goniaulix, Phalacrona, Pyrocystis, Cytterocyla, Undella* and *Dictiocystus*. On the surface *Planktionella sol* predominates, with *Asteromphale, Bidolphia* and *Sunidia thalassothrix;* among the Dinoflagellata we obtained 12 species of *Ceratium*, 5 of *Peridinium* and 22 species of other Peridinidæ; among the Tintinnidæ were a number of Sticholonga; among the Acantheriæ were especially to be noticed *Acanthometra, Acanthostaurus, Amphilonche, Collozoum, Thalassicola*, a number of *Chirospira murrayana* and a few Challengeridæ.

Our trawls brought up from the bottom many interesting fishes, among which I may mention *Bathyterois, Ipnops,* and a few bat-fishes, all thus far described by Mr. Garman from the 1891 expedition. I may mention also a *Chimæra*, different from the Chili species. The fishes have been admirably cared for by Dr. J. C. Thompson, U. S. N.

Among the crustacea were *Lithodes, Munidopsis* and many macrurans, all well-known species of the 1891 expedition. We found a few mollusks and a few interesting genera of tubiculous annelids. Compared with the 1891 expedition, few starfishes and brittle stars were obtained, and still fewer sea urchins, only one species of *Aceste* and one of *Aerope,* a marked contrast to the numerous echini collected in the Panamic Basin in 1891. We obtained, however, a magnificent collection of holothurians, nearly every species occurring in the Panamic Basin being found in numbers in our track south of the Galapagos, in the wake of the great Chili-Peruvian current and at considerable depths. On one occasion, at station 4647, in 2,005 fathoms, we obtained no less than 16 species of holothurians, among them brilliantly colored *Benthodytes, Psychropotes, Scotoplanes, Euphronides* and the like. At station 4670, in 3,209 fathoms, we obtained 6 species of holothurians. At station 4672, in 2,845 fathoms, we also obtained very many specimens of three species of *Ankyroderma*, a large *Deima*, 2 species of *Scotoplanes*, 2 of *Psychropotes,* with a number of young stages of that genus; repeating thus the experience of the *Challenger,* which found holothurians in abundance at great depth, not only in the number of specimens, but also of the species, though the *Challenger* did not at any locality obtain as many as we did at station 4647. Mr. Westergren made a number of colored sketches of the species which were not obtained in the 1891 expedition. We also collected in the trawl a number of deep-sea actinians, none different, however, from genera found previously in the Panamic district. We also obtained a few pennatulids, gorgonians and antipathes, and a very considerable number of silicious sponges, usually associated with the holothurians found in deep water in the track of the Peruvian current. In the

track of the current at not too great distances from the coast we invariably brought, even from very considerable depths, sticks and twigs and fragments of vegetable matter. On two occasions we brought up in the trawl specimens of *Octacnemus;* the trawl had been working at 2,235 and at 2,222 fathoms. Both Moseley and Herdman described this interesting ascidian as attached to the bottom by a small peduncle. While the presence of the peduncle can not be denied, yet its attachment, if attached at all, must be of the slightest, its transparent slightly translucent body, with its eight large lobes, suggesting rather a pelagic type than a sedentary form. This ascidian was discovered by the *Challenger* west of Valparaiso.

Mr. Chamberlain made two daily observations of the density of the water, and found the same discrepancies between our observations and those of 1891, with those given by the *Challenger* and in the German Atlas of the Pacific Ocean. Whenever we took a serial temperature, he also determined the density at 800 fathoms. We occupied six stations for the serial temperatures, two on the western termini of the lines normal to the coast across the great Peruvian current, two in the center of the current, and two at a moderate distance from the coast. These serials developed an unusually rapid fall in the temperature between the surface and 50 fathoms—nearly 12° at the western extremity of the northern line, the temperature having dropped from 71.7° at the surface to 59.2°. At 200 fathoms it was 51°, and at 600 fathoms it had dropped to 40.7°, the bottom temperature at 2,005 fathoms being 36.4°. The temperature of the station in the central part of the current in 2,235 fathoms agreed with the western series. At the eastern part of the line, in 2,222 fathoms, with a bottom temperature of 36.4°, the surface being only 67°, we found again a close agreement at 50 and 100 fathoms, the lower depths at 400 and 600 fathoms being from one to two degrees warmer than the outer temperatures. On taking a serial from the surface to 100 fathoms, we found that the greatest drop in temperature took place between 5 and 30 fathoms.

The temperatures of a line running due west from Callao showed a very close agreement both at the western end of the line, about 780 miles from the coast, and in the central part of the line, as well as in the shore station about 80 miles from the coast in 3,209 fathoms. The bottom temperature in nearly all the depths we sounded was 36°, a high temperature for that depth. I do not at present make any comparison with the serials taken in the Panamic district in 1891, but wait until we shall have completed our lines to the south and to the west.

We leave for Easter Island on the third of December, where we shall coal, and from there go to the Galapagos, and thence to Manga Reva and Acapulco, where we ought to arrive in the early days of March.

The changes made in the working apparatus of the *Albatross* under the superintendence of Lieutenant Franklin Swift, U. S. Navy, have proved most satisfactory. The alterations in the main drum and the device for preventing the piling of the wire on the surging drum and the accompanying shock, have greatly reduced the risk of breaking the wire rope when trawling at great depths. The wire rope has proved an excellent piece of workmanship, and has served admirably in the comparatively deep water in which most of our trawling has been done thus far. A new dredging boom has also been installed, and everything relating to the equipment of the *Albatross* has been carefully overhauled.

Lieut.-Commander L. M. Garrett has been indefatigable in his interest for the expedition; the officers and crew have been de-

voted to their work; and the members of the scientific staff have carried out most faithfully their duties of preparing and preserving the collections thus far made.

We hoped to be docked at Callao, but owing to the prolonged occupation of the dock by a disabled steamer and the uncertainty of its becoming free within reasonable time, we decided to proceed without further delay to Easter Island and continue the expedition as we are.

ALEXANDER AGASSIZ.

SCIENTIFIC BOOKS.

Rational Geometry. By GEORGE BRUCE HALSTED. New York and London, John Wiley and Sons. 1904. Pp. viii + 285.

For over two thousand years there has been only one authoritative text-book in geometry. 'No text-book,' says the British Association, 'that has yet been produced is fit to succeed Euclid in the position of authority!' There is, in fact, little improvement to be made in Euclid's work along the lines which he adopted, and among the multitude of modern text-books, each has fallen under the weight of criticism in proportion to its essential deviation from that ancient author.

This does not mean that Euclid is without defect, but starting from the discussion of his famous parallel postulate, the modern development has been in the direction of the extension of geometrical science, with the place of that author so definitely fixed that the system which he developed is called *Euclidean geometry*, to distinguish it from new developments. The defects of Euclid arise out of a new view of rigorous logic whose objections seem finely spun to the average practical man, but which are based upon sound thought. The key to this modern criticism is the doubt which the mind casts upon the reliability of the intuitions of our senses, and the tendency to make pure reason the court of last resort. Thus, the sense of point between points, the perception of greater and less and many other tacit assumptions of the geometrical diagram, are the vitiating elements on which modern criticism concentrates its objections.

As an evidence of the ease with which the senses can be made to deceive, take a triangle ABC, in which AC is slightly greater than BC. Erect a perpendicular to AB at its middle point to meet the bisector of the angle C in the point D. From D draw perpendiculars to AC, BC, meeting them respectively in the points E, F. Let the senses admit, as they readily will in a free-hand diagram, that E is between A and C, and F between B and C; then from the equal right triangles $AED = BFD$, $DEC = DFC$, we find $AE = BF$, $EC = FC$, and, by adding, $AC = BC$, whereas AC is in fact greater than BC.

Are we to take our eyes as evidence that one point lies between two other points, or how are we to establish that fact? This query alone lets in a flood of criticism on all established demonstrations. The aim of modern rational geometry is to pass from premise to conclusion solely by the force of reason. Points, lines and planes are the names of things which need not be physically conceived. The object is to deduce the conclusions which follow from certain assumed relations between these things, so that if the relations hold the conclusions follow, whatever these things may be. Space is the totality of these things; its properties are solely logical, and varied in character according to the assumed fundamental relations. Those assumed relations which develop space concepts that are apparently in accord with vision constitute the modern foundations of Euclidean space.

Mr. Halsted is the first to write an elementary text-book which adopts the modern view, and in this respect, his 'Rational Geometry' is epoch-making. It is based upon foundations which have been proposed by the German mathematician, Hilbert. In point of fact, the book contains numerous diagrams, and is not to be distinguished in this respect from ordinary text-books, but these are simply gratuitous and not necessary accompaniments of the argument, designed especially for elementary students whose minds would be unequal to the task of reveling in the domain of pure reason. Also, in opening the book at random, one does not recognize any great difference from an ordinary geometry. In other words, those as-

sumed relations are adopted which lead to Euclidean geometry. In this respect the author is appealing to the attention of elementary schools, where no geometry other than the practical geometry of our world has a right to be taught.

The first chapter deals with the first group of assumptions, the assumptions of association. Thus, the first assumption is that *two distinct points determine a straight line.* This associates two things called points with a thing called a straight line, and is not a definition of the straight line. The definition of a straight line as the shortest distance between two points involves at once an unnamed assumption, the conception of distance, which is a product of our physical senses, whereas the rational development of geometry seeks the assumptions which underlie and are the foundations of our physical senses. In the higher court of pure reason, the testimony of our physical senses has been ruled out, not as utterly incompetent, but as not conforming to the legal requirements of the court. However, there is no objection to shortness in names, and a straight line is contracted into a *straight,* a segment of a straight line, to a *sect,* etc.

In the second chapter we find the second group of assumptions, the assumptions of betweenness, which develop this idea and the related idea of the arrangement of points. In the next chapter we have a third group, the assumptions of congruence. This chapter covers very nearly the ordinary ground, with respect to the congruence of angles and triangles, and all the theory of perpendiculars and parallels which does not depend upon Euclid's famous postulate. This postulate and its consequences are considered in chapter IV.

All the school propositions of both plane and solid geometry are eventually developed, although there is some displacement in the order of propositions, due to the method of development. Numerous exercises are appended at the end of chapters, which are numbered consecutively from 1 to 700.

Undoubtedly the enforcement upon logic of a blindness to all sense perceptions introduces some difficulties which the ordinary geometries seem to avoid, but as in the case of our conception of a blind justice, this has its compensation in the greater weight of her decisions. It seems as if the present text-book ought not to be above the heads of the average elementary students, and that it should serve to develop logical power as well as practical geometrical ideas. Doubtless, some progressive teachers will be found who will venture to give it a trial, and thus put it to the tests of experience. At least, the work will appear as a wholesome contrast to many elementary geometries which have been constructed on any fanciful plan of plausible logic, mainly with an eye to the chance of profit.

ARTHUR S. HATHAWAY.
ROSE POLYTECHNIC INSTITUTE.

A Treatise on the British Freshwater Algæ. By G. S. WEST, M.A., A.R.C.S., F.L.S. Cambridge, The University Press. 1904.

Certainly there is no book upon any phase of cryptogamic botany for which there has been so much need, and for which the demand, in recent years, has been so great, as one dealing comprehensively with the fresh-water algæ. It is nearly twenty years since any work of the kind has appeared in English, and whatever may have been said in favor of the works of Cooke and Wolle when they were published, there can be no question about their having been out of date for a long time. Indeed, the tremendous strides made in algology during the last ten years has made it difficult for any one but the specialists to keep informed regarding the physiology, phylogeny and morphology of this group, to say nothing of the new genera and species. Of the fresh-water algæ alone, approximately one fourth of the genera now recognized have been described since the appearance of Engler and Prantl's classification in 1890. Consequently, nearly all of the important literature upon the algæ has been in periodicals and separates, often difficult to obtain, the result being that the general student of botany has, of necessity, been many years behind in his ideas regarding this most important and interesting group of plants.

G. S. West is well known as a contributor to journals upon algological subjects, notably the Conjugateæ, and for many reasons the author of 'British Freshwater Algæ' is particularly well qualified to write such a book. One can not but regret, however, that he saw fit to confine himself to British species. A treatise of this kind, so long waited for, should be as complete as possible, and when one looks in vain for *Pleodorina, Platydorina* and many other important genera which fit in so perfectly with the forms previously described, it leaves this treatise upon the fresh-water algæ in an unsatisfactory condition that hardly seems necessary. The fact that none of the Temnogametaceæ or Pyxisporeæ have been found in Great Britain seems a poor reason for excluding a discussion of these important groups in a book by West. Perhaps it is ungrateful to criticize a book which contains so much more than any previous one of its kind, for not containing all upon the subject, but the satisfactory way in which the included forms have been discussed makes it the greater pity that the plan of publication or other considerations made it necessary to confine the scope of the book to the British forms alone.

A good general discussion of the methods of multiplication and reproduction in algæ, together with a reference to the question of polymorphism and a rather full exposition of the particular theories of the author regarding phylogeny, precedes the specific treatment of the six classes, Rhodophyceæ, Phæophyceæ, Chlorophyceæ, Heterokonteæ, Bacillarieæ and Myxophyceæ. These classes, with their included genera, constitute an arrangement very different from that found in the average textbook or even in more pretentious publications, and offers a wide field for discussion. While in the main following the suggestions of Borzi, Blackman, Bohlin and others, there are certain divergences for which there does not always seem to be justification. On the other hand, long experience with certain groups has enabled Professor West to adopt what seems to be a more natural and satisfactory disposition of some forms than that followed by either Bohlin or Blackman and Tansley. On the whole, the classification is based upon the results of careful observations of the plants themselves, rather than a mere theoretical arrangement. Whether the author is justified, by the evidence at hand, in including the rather heterogeneous Syngeneticæ under the Phæophyceæ, or whether the Conjugateæ may not after all be regarded as a unicellular order which has come from the Volvocaceæ, with other disputed points, will probably require more facts before they can hope to be definitely settled. Nevertheless, it would be difficult to produce a system of classification which in the present state of our knowledge would be more satisfactory to a large number and at the same time recognize at least most of the investigations of recent years calculated to throw light upon the subject.

Attempts to revise the nomenclature for the purpose of putting the names of the principal genera upon a more stable and satisfactory basis have been made, not always, however, with success. That is, the rules adopted at one place seem to have been disregarded in another, resulting in a lack of consistency which can not but weaken any attempt to modify the names of well-established genera and species.

The book is fully illustrated and too much can not be said for the successful effort to secure new and accurate drawings of not only the more recently described genera, but for the older forms as well. It certainly is refreshing to be able to look through a book of this kind without seeing all of the old cuts of algæ that have done service since there began to be any literature upon the subject.

The need for a treatise upon the fresh-water algæ has been referred to; that this book will come as near to filling such a need as one of its scope, written by one man, could possibly be expected, is all that is necessary to say regarding its worth.

GEORGE T. MOORE.

BUREAU OF PLANT INDUSTRY.

SCIENTIFIC JOURNALS AND ARTICLES.

THE December number (volume 11, number 3) of the *Bulletin of the American Mathematical Society* contains the following articles: Report of the October Meeting of the

American Mathematical Society, by F. N. Cole; 'The Fundamental Conceptions and Methods of Mathematics,' by Maxime Bôcher; 'The History of Mathematics in the Nineteenth Century,' by James Pierpont; 'De Séguier's Theory of Abstract Groups' (Review of de Séguier's Eléments de la Théorie des Groupes Abstraits), by L. E. Dickson; Shorter Notices (Cajori's Introduction to the Modern Theory of Equations, by L. E. Dickson; Annuaire Astronomique pour 1905, by E. W. Brown); Notes; New Publications. The January number of the *Bulletin* contains the following articles: 'The Group of a Tactical Configuration,' by L. E. Dickson; 'Application of the Theory of Continuous Groups to a Certain Differential Equation,' by J. E. Wright; 'On the Quintic Scroll having a Tacnodal or Oscnodal Conic,' by Virgil Snyder; 'On the Deformation of Surfaces of Translation,' by Burke Smith; Report of the International Congress of Mathematicians at Heidelberg, by H. W. Tyler; Report of the Sectional Meetings of the Heidelberg Congress, by E. B. Wilson; Notes; New Publications.

The contents of the December issue of the *Journal of Terrestrial Magnetism and Atmospheric Electricity* are as follows:

Portrait of Ettrick W. Creak, Frontispiece.

F. Bidlingmaier: 'Ueber den Einfluss der Torsion bei den Ablenkungen eines hängenden Magneten.'

L. A. Bauer and G. W. Littlehales: 'Proposed Magnetic Survey of the North Pacific Ocean by the Carnegie Institution.'

W. Sutherland: 'On the Cause of the Earth's Magnetism and Gravitation.'

L. A. Bauer: 'The Physical Decomposition of the Earth's Permanent Magnetic Field. No. V.: Systems of Magnetic Forces Causing the Secular Variation of the Uniform Portion of the Earth's Magnetism.'

Biographical Sketch of Ettrick W. Creak.

Letters to Editor: Interruptions to Telegraph Lines in New South Wales, Australia, as observed from the Chief Office (Sydney), on October 31, 1903, O. J. Klotz; Principal Magnetic Disturbances recorded at Cheltenham Magnetic Observatory, Sept. 1 to Nov. 30, 1904, W. F. Wallis; Some Observations of the Diurnal Variation of the Magnetic Declination at Cuajimalpa, Mexico, M. Morenoy Anda.

Notes, Abstracts, Reviews, and list of recent publications.

The Journal of Infectious Diseases (Volume 2, No. 1) contains the following articles:

David J. Levy: 'Some Physical Properties of Enzymes.'

Maximilian Herzog: 'Fatal Infection by a Hitherto Undescribed Chromogenic Bacterium, Bacillus Aureus Fœtidus.'

E. O. Jordan and Mary Hefferan: 'Observations on the Bionomics of Anopheles.'

George H. Weaver, R. M. Tunnicliff, P. G. Heinemann, May Michael: 'Summer Diarrhœa in Infants.'

Albert Woelfel: 'Identification of Alcohol-Soluble Hemolysins in Blood Serum.'

Richard P. Strong: 'Protective Inoculation against Asiatic Cholera.'

L. Hektoen and G. F. Ruediger: 'Studies in Phagocytosis.'

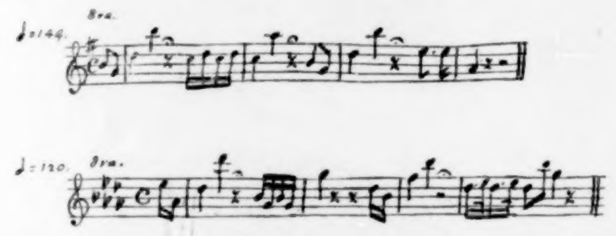
SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

The 392d regular meeting was held December 5, 1904. G. K. Gilbert spoke briefly of observations of the marks of the claws of bears and other animals upon the bark of the aspen in the Sierra Nevada Mountains of California. Photographs of the trunks of trees so marked and specimens of the bark were exhibited.

Henry Oldys, under the title 'Some New Bird Songs,' gave an account of interesting songs noted by him in the spring of 1904. Most of these offered additional evidence of the use by birds of rules of construction that govern human music. The speaker reproduced, among others, several chewink songs, all of which were sung by one chewink. Two songs of a wood thrush, which were given, the speaker declared the most remarkable songs he had heard in years of experience. Each followed a form common in the modern four-line ballad and each was a model of melody. Hitherto, this four-phrase form had been found only in the morning and evening song of the wood pewee and in the usual song of the summer tanager, and neither had the melodic beauty that characterized the two wood thrush

songs. These are of such interest as to be worthy of reproduction as follows:



William H. Dall read an abstract of the results of the study of the non-marine mollusk fauna of Alaska and the adjacent parts of Asia and North America, in which the relations of the east Siberian fauna to that of Europe, China and Japan; and of the Hudson Bay territorial fauna to that of eastern Canada, the Mississippi Valley and the Pacific slope were shown, and those of all the foregoing to the fauna of Alaska as at present known. He regarded the probability of many new forms being found in these regions as very small, for though still very imperfectly explored, the conditions on the whole are very uniform, and in some portions of the area quite thorough collecting has been done.

B. W. Evermann spoke of 'A Trip to Mount Whitney,' giving account of personal experiences while on a trip with the pack train into the region of Mount Whitney, California, in search of the golden trout of Volcano Creek.

THE 393d regular meeting was held December 17, 1904. Dr. E. L. Greene spoke on 'The Earliest Book of Systematic Botany,' discussing the absence of everything approaching a natural classification of plants in ancient and mediæval botanical works, following with a statement of the principles first enunciated by the Italian Cæsalpinus in his book 'De Plantis' (1583), that plants and trees admit of a natural arrangement by considering the characteristics of their fruit and seeds; thus inaugurating the era of systematic botany. A cursory review of this book was given and statements made of that imperfect, though in general very natural sequence of genera which it exhibits.

A. B. Baker spoke briefly of 'Animals Recently Received at the National Zoological Park from Abyssinia and South America.' Among those mentioned were the animals received through President Roosevelt, to whom they were presented by King Menelek, of Abyssinia. Most interesting of these are the Somali ostrich, probably the only one of its kind in this country; the Grevy zebra, perhaps the handsomest of zebras; and two peculiar gelada baboons. He also spoke of animals received from South America through the U. S. Consul at Asuncion and by exchange with the Zoological Garden of Buenos Aires. These included a jaguar, guanacos, peccaries, capybaras, rheas, tinamous and a crested screamer.

Dr. Hugh M. Smith gave an account of the Japanese ayu or sweet-fish (*Plecoglossus altivelis*), which in some respects is one of the most remarkable of fishes. It is one of the Salmonidæ, but differs markedly from the salmons and trouts, and has been made the basis of a separate subfamily by Dr. Theodore Gill. The ayu is an annual fish, the entire cycle of its life from the egg to its death covering not more than a year. In dying after once spawning, it resembles the Pacific salmons. The eggs, laid in fall in rivers, are attached to stones, and hatch in a much shorter time than those of any other member of the family. The migrations are very peculiar, embodying a combination of anadromous and catadromous which is unparalleled; strictly speaking, however, the fish is neither anadromous nor catadromous, for it does not ascend the streams to spawn, and when it runs down the streams to spawn it does not go to sea. When young the ayu subsists on animal food, but after entering fresh water it feeds almost exclusively on algæ, which it scrapes from stones in mountain streams by means of curious chitinous papillæ which develop on the lips. The method of catching the ayu with trained cormorants was described and illustrated by lantern slides.

WILFRED H. OSGOOD,
Secretary.

NEW YORK ACADEMY OF SCIENCES: SECTION OF GEOLOGY AND MINERALOGY.

THE meeting of January 9, 1905, was called to order by the chairman, Dr. E. O. Hovey;

twenty-eight persons present. The minutes of the last meeting were read and approved.

Dr. George F. Kunz read a paper on the 'Jagersfontein or Excelsior-Tiffany Diamond,' the largest diamond ever found up to the present time. It weighed 970 carats, and was a gem of most marvelous purity. This diamond was most expertly cleaved into pieces, and from it were cut ten gems weighing from 13 to 68 carats each; a total of 340 carats; and these were imported into the United States. Mr. Kunz also stated that carbon silicide had been detected in the meteorite from the Cañon Diablo by Dr. Henri Moissan, of Paris, together with transparent diamond and black diamond. As carbon silicide has been made artificially with the electric furnace by Messrs. Cowles, Acheson and Moissan heretofore, and was first determined in nature by Professor Moissan, if agreeable to Professor Moissan, he would suggest the name *moissanite* for this compound.

The paper was illustrated by models and photographs. It was discussed by Professors Kemp and Stevenson, the chairman, and others. Brief replies were made by Dr. Kunz.

Professor J. J. Stevenson read a paper entitled, 'Recent Advances in our Knowledge of the Composition of Coals.' He said that the coals of Spitzbergen, according to Nathorst, are in great part of Jurassic age. The mining operations are confined to Advent Bay, a branch of the ice fiord of West Spitzbergen, where coal has been opened on both sides of the bay. The deposit has been followed northwardly for about ten miles, and for an equal distance westwardly.

The chief enterprise is on the easterly side of the bay, where the bed is somewhat less than five feet thick. The coal from the upper part is splint-like, while that from the lower part is brilliant and somewhat prismatic. The divisions show a notable difference in the percentage of volatile, the upper containing about ten per cent. more than the lower. The coal shows no tendency to coke, and that from the lower portion is attacked energetically by caustic potash.

The coal was compared with that from other localities in which the benches show notable difference in volatile. The results of tests with caustic potash made upon a number of coals appeared to show that non-coking coals are attacked promptly, while coals yielding a firm coke are not affected even after prolonged boiling. The speaker promised to give at a future meeting the results of an extended series of tests.

The paper was discussed by Professor Kemp and others.

The last speaker was Professor J. F. Kemp, upon 'New Sources of the Supply of Iron Ores.' Emphasis was first placed upon the enormous demands made by the iron industry of to-day upon the mines of the United States, Great Britain and Germany. The conviction was held by many that within fifty years the local American sources of rich ores of whose existence we now know would be exhausted and the iron masters would be compelled to seek new deposits. The following possible new districts were passed in review: the Labrador prospects discovered by Mr. A. P. Low, of the Canadian Geological Survey, which might also ship to Europe; Adirondack areas of reported magnetic attraction and possible lean ores, the Temagami district and the Michipicoten range, Ontario; the southern continuation of the Marquette range beneath the drift; the southern half of the Mesabi probable syncline beneath the swamps northwest of Duluth, as suggested by C. P. Berkey; the Baraboo range; the deposits in Iron County, Utah, and in the Wasatch Mountains; the magnetites of southern California and the prospects in Washington and along the coast. The speaker emphasized the important reserves in the titaniferous magnetites and their great quantity.

Passing to Europe the new developments in Sweden at Gellivara and Kirunavaara were reviewed and the possibilities at Routivaara; also the Dundeland valley in Norway and the similar deposits farther north. Their relations to the smelting centers in Great Britain and Germany were explained and their comparative amount with the 'minette' ores of France, Luxemburg, and Germany brought out. Other deposits in Spain, Algiers, Ven-

ezuela, India, Australia and Shan-si in China were mentioned.

The necessary connection between the coal fields and any great development of the iron and steel industry was emphasized and the future of the three great producers of to-day forecast as involved in the permanency of the coals. The reserves of coal are greater in Germany and America than in Great Britain. The province of Shan-si, China, having rich stores of both coal and iron, seems to be the one possible new location of the future great iron industry.

After a lengthy discussion, the meeting adjourned.

A. W. GRABAU,
Secretary.

COLUMBIA UNIVERSITY,
NEW YORK CITY.

THE SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

THE third regular meeting of the club for the year 1904–5 was held on December 13 at 7:30 P.M. in the physical lecture room of science hall. The lecture of the evening was delivered by Professor B. W. Snow, head of the department of physics of the university, on the subject, 'Electrons, Radio-activity, and the Electrical Theory of Matter.'

F. W. WOLL,
Secretary.

DISCUSSION AND CORRESPONDENCE.

A BIOLOGICAL STATION IN GREENLAND.

TO THE EDITOR OF SCIENCE: The establishment during recent years of biological stations in various parts of the world has proved to be of the greatest importance in furthering the progress of science. The great station of Naples has now a worthy competitor at Wood's Hole, and the botanical laboratory at Buitenzorg is aptly represented in this country by the Carnegie Desert Laboratory. The already large number of lesser institutions of similar nature is rapidly increasing, both in this country and abroad, and all add to the opportunities available for the working biologist.

Up to the present time the foundation of such stations has been confined, however, to regions with temperate or tropical climate, and no attempt has been made to establish a permanent station for biological research within the Arctic, until recently. A Danish botanist, Morten P. Porsild, has proposed to his government the appropriation of funds for such a station, to be located on the southern coast of Disko Island in North Greenland, not far from the colony Godhavn (lat. 69° 15′ N.). The proposal is well worth the attention and support of American scientists, and I shall here briefly review Mr. Porsild's plan, according to information supplied by himself.

Danish naturalists have, during the last twenty-five years, systematically explored Greenland; more than fifty scientific expeditions have been sent to that country, and the results are comprised in a series of about thirty volumes ('Meddelelser om Grönland'). It is with pardonable pride Mr. Porsild points to the fact that this has been accomplished at a cost not greater than the expense for one of Peary's expeditions.

The estimated cost for the establishment of the proposed station reaches the very moderate amount of $9,400, which would cover the erection of building, purchase of a motor launch, boats, sledges, tents and other material for shorter expeditions, instruments, books, etc. The running expenses, including salary for a resident investigator and native assistants, are estimated at $2,960. Mr. Porsild has asked the Danish government for this sum, and in the interest of science it is sincerely to be hoped that his request will be granted. If that is done, Mr. Porsild expects to have the station in working order before next summer, and its doors will then be thrown open for investigators from any country. The geographical position of Greenland, and the similarity of conditions there with those of the northernmost part of this continent must necessarily appeal to Americans, and until the time arrives when a permanent biological station can be established in a suitable locality in Alaska, those engaged in arctic work will find the now proposed institution a place of interest. For reasons which will be given Greenland will always be the classical ground for certain lines of research, and, as Mr. Porsild says, there is no other place in the Arctic

that offers such favorable conditions as the region in which he proposes to establish his station. The southern coast of Disko has the richest flora and the most luxuriant vegetation in northern Greenland. It is the northernmost point where all the different plant formations of Greenland are represented. Cretaceous and Tertiary formations with rich deposits of fossils occur, and both gneiss and basalt rock formations are here represented. The inland ice and the high mountains are easily accessible, glaciers in all stages, fjords and rivers, and the open sea give an excellent opportunity for investigations. All the main features of arctic climate are found here. The sun does not rise over the horizon for over six weeks, and for a still longer period of the summer it does not go down. The colony Godhavn is the center of commercial life in northern Greenland, and it has regular communication with Copenhagen.

The station will be in charge of a resident investigator, and accommodation will be provided for two visitors, who will have the use of all facilities the laboratory can offer, free of charge. By the establishment of this station the total expense to a visiting scientist will be reduced to about one third of previous cost. It is estimated that a stay for a summer will cost $375, this sum covering the fare both ways between Copenhagen and Greenland. A prolonged sojourn will add proportionally a small sum only.

Among the researches which should be carried on partly by the resident investigator, partly by visiting biologists, Mr. Porsild draws attention to the following general problems: What environmental factors cause the peculiar aspect of arctic plants and plant communities? What internal and external qualities make it possible for arctic plants to exist under conditions too severe for any other plants? These two headings necessarily include a great number of special inquiries into structure, nutrition, growth, respiration, transpiration, variation and adaptation, flowering and propagation of plants, development, competition and succession of plant communities, problems for the solution of which the conditions in the arctic regions are especially favorable, but which require detailed experiments and observations, covering a long period of time. In the preface to his principal work, 'Plant Geography upon a Physiological Basis,' the late Professor A. F. W. Schimper (1898) suggests the foundation of a botanical station such as now proposed by Mr. Porsild, when he says: "It is to be hoped that a counterpart to Buitenzorg may soon be established in the arctic zone; for an arctic laboratory, with a modest equipment corresponding to the poverty of the flora and the relative simplicity of the problems to be solved would be of great service." Only a few problems of plant physiological interest may here be mentioned as subjects for investigation at a botanical laboratory in the Arctic. It has recently been shown that a great number of arctic plants are supplied with mycorrhiza. The question has arisen to what extent ready prepared food material is absorbed by means of this symbiotic relation under the prevailing light conditions in the arctic region. The process of photosynthesis in green plants must necessarily be retarded by the insufficient light. It is generally supposed that the long arctic day is a compensation to the plants for the short period of growth. This has not yet been proved, however, by real evidence. We do not know, as yet, how small amount of light is necessary to bring about absorption of carbondioxide in the green plants of the Arctic. We have no data, except occasional observations by travelers, as to the peculiar results on vegetation of the Arctic temperatures. Such facts as willows flowering and budding as soon as they reach over the surface of the snow, while their lower parts are still frozen, are, as yet, unexplained. Similarly the phenomenon of plants growing and flowering on steep mountain sides, where they are exposed to a temperature of 30° C. in daytime and several degrees under zero at night, and to extremely low temperatures in winter without any snowcovering. The adaptations in arctic plants for conservation of the water supply or minimizing the transpiration are still imperfectly known. The ecology of roots of arctic plants is hardly studied at all. The succession of plant communities on new soil, left bare by

the ice, is a problem which can not be studied to advantage anywhere better than in Greenland, where similar conditions now prevail as once obtained in the glaciated area of both the northern and the southern hemisphere. These are only a few of the most important botanical questions which have to be solved at an arctic station.

The resident investigator should make detailed meteorological observations. Near the proposed site for the laboratory are mountains 2,000 to 3,000 feet high, and easily accessible. Mr. Porsild proposes to place self-registering instruments in a hut on the top of the mountain, so that simultaneous readings could be had from near sea level and from the high mountain—a matter of great consequence. In this connection also phenological observations would be taken.

Among the problems of geological interest, for the study of which Greenland offers special advantages, may be mentioned the study of glaciation, and of the extremely rapid erosion, that takes place in the northern part of the country. Certain parts of the coast are known to be sinking, in the basaltic regions of north Greenland earthquakes are not infrequent, and a trained observer, living in the country the whole year round and supplied with necessary instruments, could do good service by obtaining data on these phenomena. Large collections of plant fossils have already been brought home from these regions, but still much remains to be done in paleontological research.

Of zoological subjects especially plankton studies could be undertaken, and a series of observations of the periodicity of plankton, together with data on salinity and temperature of the sea water would be of considerable interest for an understanding of the animal life in the high arctic seas.

Mr. Porsild, who is now connected with the botanical department of the University of Copenhagen, has already done good work in the study of arctic plant life, and if he undertakes the work of the resident investigator, it can be taken for granted that results of permanent value to biological science will follow the founding of the new institution. The plan of establishing an arctic biological station in north Greenland, as proposed by Mr. Porsild, has received the endorsement of all the scientific institutions in Denmark, and the hearty approval of scientists in northern Europe. It now remains to be seen whether the Danish government is aware of the importance of this proposal and willing to take the necessary steps for its realization.

PEHR OLSSON-SEFFER.

STANFORD UNIVERSITY, CAL.,
December 5, 1904.

SPECIAL ARTICLES.

THE DEXTER, KANSAS, NITROGEN GAS WELL.*

DURING the first half of 1903 parties drilling for oil or gas at Dexter, Kansas, came into a gas sand at a depth of about 400 feet which yielded a large amount of gas. It was soon closed in and an attempt was made to burn it, as natural gas is usually burned, for generating steam for drilling purposes. Much to the surprise of parties interested, it would not burn. Later it was found that when a fire was already kindled in a fire box or an engine and the gas turned on, as is usually done with natural gas, it would begin to burn, and would develop sufficient heat to generate steam moderately well. But as soon as the coal or other fuel in the fire box was consumed the gas would no longer burn. A cylinder of the gas was shipped to the University of Kansas later during the summer and was partially examined by different members of the chemical and geological departments.

This peculiar gas obtained from the ground in a manner similar to the way natural gas is ordinarily obtained, and in a region where gas might reasonably be expected, at once became an object of great interest. The owners of the well, who had spent their money in developing it, did not wish it given great publicity. But newspaper men wrote it up and oil and gas men generally spoke of it as a well of 'hot air.' Accordingly, the state geologist deemed it of sufficient interest to warrant a careful investigation. On his advice the well

* Presented in abstract at the meeting of the Geological Society of America at Philadelphia, December 30, 1904.

was opened up and allowed to flow freely through an $8\frac{1}{4}$-inch pipe for eleven days, and then through a 3-inch pipe three days more. The gas was again tested by trying to burn it in boilers, stoves and other places. But it was found to have practically the same character as when first obtained. During this long flow the well 'drilled itself in' to a considerable extent; that is, the escaping gas broke the upper part of the gas-bearing sandstone, blew the particles out through the casing and thereby deepened the hole. The static pressure of the gas at present is 120 pounds, and the flowage capacity, measured by the ordinary method using the pitot tube and Robinson's tables, is reported to be seven million cubic feet per twenty-four hours. These measurements have not been verified by the state survey, but the parties making them are so well known it is safe to assume they are approximately correct.

An ordinary gas-receiving cylinder with an opening at each end was now shipped down to the well and was filled with gas by the ordinary replacement method, the cylinder first being filled with water. The full pressure of the well was admitted to the cylinder, the valves securely closed, and the same shipped to Lawrence for analysis. The analysis of the gas was made by the junior author of this article and gave results as follows:

Oxygen	0.20
Carbon dioxide	0.00
Carbon monoxide	0.00
Methane, CH_4	15.02
Hydrogen	0.80
Nitrogen	71.89
Inert residue	12.09
Total	100.00

The analysis was carried out chiefly by means of the well-known methods given in Hempel's 'Gas Analysis.'

Methane was determined by combustion of the gas with pure oxygen and measurement of the resulting contraction, and also of the carbon dioxide formed in the combustion. Hydrogen was absorbed in a palladium tube; carbon dioxide was tested for with a potassium hydrate pipette and carbon monoxide with ammoniacal cuprous chloride solution. For the determination of oxygen a phosphorus pipette was used. The residual gas left unabsorbed after all the above operations was treated by the method used by Ramsay and Rayleigh in the separation of argon from atmospheric nitrogen (*Journal of London Chemical Society*, 1897, 181). The residue was mixed with an excess of pure oxygen and confined in a tube over mercury. A small quantity of a strong solution of potassium hydroxide was introduced into the tube over the mercury and a spark from an induction coil was passed through the mixture for about sixty hours. The nitrogen peroxide formed in the operation was absorbed by the solution of potassium hydroxide. The sparking was continued for several hours after all contraction in the volume of the gas had ceased, and the residue was then removed from the tube and passed into a phosphorus pipette filled with fresh phosphorus. Here it was kept for several hours to insure the complete absorption of the excess oxygen. The residue which failed to be absorbed was then measured. This constitutes the portion which is designated in the analysis as inert residue. No examination into the constitution of this residue has yet been made, because of lack of time, and until this is done nothing can be said concerning its composition, save that there is a possibility of its containing argon or other inert gaseous elements which have been found in atmospheric air.

The investigation of the inert gases will be carried out as soon as time will permit.

Geologically the mouth of the well is in the Permian, and the gas-bearing sandstone is close to the division line between the Upper Coal Measures and the Lower Permian. No caves or underground caverns of any importance ever have been found in this part of the state. The formations are a mixture of alternating beds of limestone and shale, with comparatively small amounts of sandstone found here and there in the shale. The gas itself, it should be remembered, occurs in sandstone in the same manner that ordinary natural gas occurs in other sandstones farther east. Naturally one is led to inquire whence

this large amount of nitrogen which has already flowed from the well, an amount equal to not less than 125 million cubic feet measured at atmospheric pressure. A little farther east in the state there are hundreds of natural gas wells which produce a natural gas similar to that of Indiana, Ohio and Pennsylvania. For comparison a few analyses from different places in the state are here added, made by Professor E. H. S. Bailey, of the University of Kansas, years ago.

CHEMICAL COMPOSITION OF KANSAS NATURAL GAS. EXPRESSED IN PER CENTS.

Components of Gas.	Paola.	Osawatamie.	Iola.	Cherryvale.	Coffeyville.	Independence.
Hydrogen, H	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen, O	0.45	trace	0.45	0.22	0.12	trace
Nitrogen	2.34	0.60	7.76	5.94	2.21	3.28
Carbon m-oxide, CO.	1.57	1.33	1.23	1.16	0.91	0.33
Carbon dioxide, CO_2	0.33	0.22	0.90	0.22	0.00	0.44
Ethylene series, C_2H_4, etc	0.11	0.22	0.00	0.00	0.35	0.67
Marsh gas, CH_4	95.20	97.63	89.66	92.46	96.41	95.28

It will be seen from the above table that oxygen is present in small quantities in almost all the samples analyzed and that nitrogen is present in all of them, reaching to a little over seven per cent. in gas from Iola. It is possible, of course, that a small amount of air was left in the gathering flask, but not probable. If so the amount of oxygen present would correspond to a proportionate amount of nitrogen, much less than is given in the table. Therefore, we may conclude that traces of nitrogen are usually present in Kansas natural gas. Carbon monoxide and carbon dioxide also are present in small quantity, but almost all the volume is marsh gas, CH_4, which reaches 97.63 per cent. in one sample. But in the Dexter gas no oxides of carbon could be found.

If we assume that the Dexter gas represents a volume of air which in some way was embedded hundreds of feet beneath the surface, then a number of interesting inquiries are presented, such as: What became of the oxygen? If it was consumed or absorbed by organic matter then why is the gas totally void of the oxides of carbon which are found present in small quantities in almost all natural gases? Is it possible that ground water absorbed the oxygen from a mass of air, leaving large quantities of nitrogen unabsorbed? Under ordinary conditions the ratio of absorption for oxygen and nitrogen by water is different from the ratio between the two gases in the atmosphere. It is possible that ground water simply absorbed the oxygen, leaving a residue of nitrogen unabsorbed. It must be confessed this hardly looks probable. But even if it is possible the most important question yet remains, namely, how did so large a volume of air become entombed in the ground? The writers hereof are unable to advance any views on this phase of the subject.

ERASMUS HAWORTH,
D. F. MCFARLAND.

COMMENT.

Under the view that the earth's atmosphere and hydrosphere represent volatile matter forced out from the interior of the shrinking globe, the Dexter nitrogen supply is simple and natural. It is one of many indications that the interior supply of gases is not exhausted and that the atmosphere is still growing.

H. L. FAIRCHILD.

THE TEACHING OF AGRICULTURE IN SOUTH CAROLINA.

CLEMSON AGRICULTURAL COLLEGE of South Carolina has recently completed a commodious building for the purpose of teaching the sciences related to agriculture. This building was dedicated to its use on August 9, by appropriate exercises. On that occasion Hon. J. E. Tindal, of South Carolina, delivered an address and dedicated the building to the prosecution of agricultural sciences. There was present a large audience of farmers and prominent men from different portions of South Carolina and neighboring states. The following is a synopsis of Mr. Tindal's speech:

The dedication of the building, he said, marks the seeming completion of the college. This building was put up last because the work of agriculture could be carried on better than could the work of other departments

without separate buildings. The money was not available to erect all buildings at once. Those in greatest demand were built first. The college is now complete with six departments. These six departments represent the great industrial forces of our great state. We are making a new era, but that era did not begin with reconstruction. South Carolina University was abolished and the South had nothing to do with that monstrosity. It began with 1876. The old South Carolina College was established. The negroes were given a college at Orangeburg, and the citadel was given to the whites at Charleston. But the old classical education, while good and while still good, did not go far enough.

The wonderful advance along industrial lines has wrought a revolution in all departments of life. These new forces of nature have been applied to all professions and trades. No education can be adequate that does not take these forces into consideration. Clemson College was founded to meet the very necessities of the times in which we live.

No individual can master the whole of the knowledge of this generation. But a man may master the world's thought in his own particular vocation. If a state has men who do this, then that state stands at the very forefront of progress. For a long time agriculture was neglected. But the learned men of Europe soon saw that the business of the world would collapse unless attention was given to agriculture. So experiment stations have been established where learned men pry into the secrets of nature as they affect human life. If any new discovery is made in any department of science, your professor of that particular line gets it and gives the benefit to our state.

Knowledge has so multiplied that men must specialize. The man who does so gains distinction and wealth and is a benefactor of the race. A man who masters the forces of nature and applies them to his vocation deserves respect. He deserves it when he is a farmer just as much as when he follows any other calling. When farmers begin to specialize then we shall have diversified farming.

You claim that we spend too much money. Why, we don't spend an infinitesimal part of what we ought to spend to bring our state abreast the times. Japan, though not much larger than South Carolina, has 175 experiment stations.

Clemson has awakened thought in our state. The farmers are beginning to realize that there is something to learn besides what they already know. It has got them out of ruts.

The success of this college depends on you. If you have a bright boy and want him to become a doctor, you send him to college; so if you want him to become a lawyer. But if he is to farm you turn him loose in ignorance. Why not educate him too?

South Carolina depends on you. This land is your inheritance. It should be the inheritance of your children. If it is to be, you must get the best knowledge obtainable.

Here Captain Tindal addressed himself to the faculty of the college, impressing upon them the responsibilities that rested upon them, and complimenting them upon what they had done. He spoke of the contribution the other departments of the college had made to the nation, but the state must look largely to the agricultural department.

Captain Tindal's speech was scholarly and forceful and was listened to with interest.

The agricultural hall contains thirty laboratories and lecture rooms. The sciences have been well provided for—general agriculture, geology and mineralogy, veterinary science, botany and bacteriology, horticulture, entomology and zoology, animal husbandry and dairying. The state experiment station is also located in this building. The board of trustees have endeavored to furnish these laboratories and lecture rooms with the best apparatus and appliances so that the teaching and experiments may be conducted in accordance with modern requirements There is also a large room in this building set aside for a museum, where the different divisions and departments will display for the use of the students scientific specimens which will also be of value to the casual observer, and to the man who is investigating some special topic in his line. The structure consists of three floors, and is built of the best

material available, finished in pressed brick and stone trimmings.

The work of Clemson Agricultural College in the line of agriculture has been greatly advanced within the last several years because of the active demand on the part of the farmers for information concerning their profession. They assemble here each year in large numbers during the middle of the summer, and spend a week with the professors of the institution and distinguished experimenters from other sections of the country, in the study of sciences relating to agriculture. The erection of this building, therefore, has been in accordance with this demand. The board of trustees are endeavoring to meet the requirements of the situation, and there is great desire on their part to give all the facilities, so far as the income of the college will allow, not only for the purpose of teaching agriculture, but at the same time for encouraging original research on the part of the gentlemen who have charge of the various divisions in the department. There seems to be a considerable awakening on the part of the people all over the state for knowledge in scientific agriculture, and in other lines of industry, and the erection of this building with its modern facilities will go far towards encouraging this awakening on the part of the industrial classes of the state.

The college was established in 1889 by an act of the state legislature, and opened for the admission of students in 1893. The first class graduated in 1896, and the college has sent out a total number of 295 graduates. The total number of students enrolled for session 1904–5 is 641, and the total number of the faculty is 44.

The college is engaged in work in the following lines of scientific and industrial activity—agriculture, mechanical engineering, electrical engineering, civil engineering, textile engineering, chemical science and the subjects of general literature necessary for an educational foundation.

The college is located on the estate of John C. Calhoun, his mansion being situated in the center of the campus. Mr. Thos. G. Clemson, son-in-law of John C. Calhoun, donated the property to the state for the purpose of a college of this character, giving 800 acres of land and $58,539 in securities. The state has added to the land so that it now amounts to 1,136 acres. The board have spent in the fifteen years since the college was founded $656,721 in the preparation of the grounds, the installation of electric lights, water works, sewerage system and the erection of nine large buildings, 36 smaller structures for college purposes and 57 residences for the faculty. The departments are well equipped with appliances and apparatus for the prosecution of work along the lines required in modern colleges.

The income of the college is from several sources and amounts to $150,287. Besides the educational work, the college is required by law to carry on experiments in agriculture for the benefit of the farmers of the state and is in charge of the inspection of fertilizers, plants and animals, and is conducting elaborate courses of farmers' institute work. It will thus be seen that Clemson College is endeavoring to do for the industrial classes of South Carolina advanced and valuable work.

The limit of age for admission to the college is sixteen years. Every year the authorities are compelled to turn off a large number of applicants for the lack of the facilities to take care of the students who are striving for the scientific education given by colleges of this character.

P. H. MELL.
CLEMSON COLLEGE, S. C.

SCIENTIFIC NOTES AND NEWS.

THE city of Berlin has arranged a competition for plans for a monument to Rudolf Virchow. It is to be placed at the intersection of Karl and Luisen Streets, a square which will henceforth be known as Virchow Platz.

PROFESSOR LEWIS BOSS, astronomer of the Dudley Observatory of Albany, N. Y., has been awarded the medal of the Royal Astronomical Society.

THE Botanical Society of America elected the following officers at the recent Philadelphia meeting: *President*, Professor R. A. Harper; *Vice-President*, E. A. Burt; *Secretary*, Dr. D. T. MacDougal; *Treasurer*, Dr.

Arthur Hollick; *Councilors,* Professors L. M. Underwood and William Trelease.

The famous singing master, Manuel Garcia, of London, who invented the laryngoscope fifty years ago, will be 100 years old March 17, 1905. The London Laryngological Society is collecting subscriptions for a present to be given to him on that occasion.

Dr. L. P. Kinnicutt, the head of the chemical department of the Worcester Polytechnic Institute, has been appointed by President Roosevelt one of the commissioners to examine and test the fineness and weight of the coins reserved by the several mints of the United States during the calendar year 1905.

Professor H. Marshall Ward has been elected president of the Cambridge Philosophical Society.

Mr. R. V. Anderson, a student in the department of geology of Stanford University, has sailed from San Francisco for Japan, where he will make a special study of geological conditions.

Assistant Professor Leonard E. Dickson, of the department of mathematics of the University of Chicago, has completed his investigations as research assistant to the Carnegie Institution of Washington for 1904.

Captain John Donnell Smith, of Baltimore, has given to the Smithsonian Institution his private herbarium consisting of more than 100,000 mounted sheets and his botanical library of nearly 1,600 bound volumes. Captain Smith's collection is probably the largest private herbarium in America, being very rich in tropical plants. As is well known Captain Smith has long been a student of the flora of the Central American countries, having published many systematic papers on the flora of Costa Rica and Guatemala. He proposes to continue these studies, and for this reason will retain for the present the custody of the greater part of his herbarium. This gift is the most important of the kind ever received by the Smithsonian Institution.

The Research Laboratory of Physical Chemistry of the Massachusetts Institute of Technology has received from the William E. Hale Research Fund a second grant of $1,000, which is being applied to an investigation upon the conductivity of fused salts carried out by Mr. R. D. Mailey under the direction of Professor H. M. Goodwin. The Carnegie Institution has also renewed the grant of $2,000 to Professor A. A. Noyes for the purpose of promoting the researches in progress in the laboratory upon the conductivity of salts in aqueous solutions at high temperatures, which are being executed by Professor W. D. Coolidge, Mr. A. C. Melcher and Y. Kato. Additional investigations are being carried on by four other research associates or research assistants as follows: upon the rate of decomposition of minerals by water by Dr. W. Böttger; upon the migration and coagulation of colloids by Dr. J. C. Blake; upon the physico-chemical properties of the solutions of metals in liquid ammonia by Mr. C. A. Kraus; and upon the dissociation relations of phosphoric acid by Mr. G. A. Abbott. Other researches—upon the dissociation-relations of sulphuric acid, upon the solubility of salts in water above 100°, upon the heat of solution of substances in relation to their dissociation, and upon the qualitative detection of certain rare metals—are being pursued by candidates for the Ph.D. degree.

Research work in chemistry at the University of Michigan is represented among University organizations by the Chemical Colloquium, which meets twice a month through the year. Reviews are presented of recently published important researches, and reports are made upon investigations carried on in the university laboratory. All instructors of the department are members of the colloquium, and graduate students and those advanced in chemistry are also eligible to membership. The following topics have been discussed at the meetings this year: October 24, 1904—Professor Edward D. Campbell, 'A Review of Clifford Richards' Work on the Constitution of Portland Cement.' November 7—Dr. William J. Hale, 'Condensations with Nitromalonic Aldehyde.' November 21—Professor S. Lawrence Bigelow, 'A Review of Some Recent Articles on Colloidal Solutions.' December 5—Assistant Professor Alfred H. White, 'The Decomposition of Am-

monia by Heat'; a report of experimental work. December 19—Assistant Professor George A. Hulett, 'Revolving Electrodes and Electro-analysis.' January 16, 1905—Professor Moses Gomberg, 'A Review of the Literature in Tetravalent Oxygen.'

WE learn from *The Botanical Gazette* that the Botanical Society of America, the Society for Plant Morphology and Physiology and the American Mycological Society, through committees of conference, have agreed upon certain general principles, upon the basis of which they will fuse into one national society under the name of The Botanical Society of America. For some years the names of all the societies will appear upon official publications until the union is thoroughly known. There are to be two classes of membership, members and associates, the distinction being placed upon published work. The fees are to be $5 a year. Grants for research are to be made from the income. Meetings are to be annual with no permanently organized sections, but free opportunity for local meetings or temporary sections in charge of committees. A joint committee has been formed to prepare a constitution for the united societies, which shall embody the principles agreed to, and complete the reorganization.

A CABLEGRAM to the New York *Herald* says that Professor Curie has sent through the Austrian ambassador, a tube of radium to the Vienna Hospital for use in the cure of lupus. The gift is a recognition of the act of the Austrian government in furnishing Professor Curie with pitchblende for his original researches.

THE government of the northwest territories of Canada is establishing a new bacteriologic and pathologic laboratory and has appointed Dr. George Charlton, formerly of the McGill University pathologic department, chief of the laboratory.

THE department of geology of the American Museum of Natural History has recently received a series of fossils from the beds of Hudson River age near Cincinnati, Ohio. All the specimens are in beautiful condition and many rare forms, especially of Echinoderms, are represented by several specimens.

THE king of Italy has given $20,000 towards the expenses of the exhibition to be held in Milan in 1906 in celebration of the opening of the Simplon tunnel.

AMONG the recent contributions received by the Imperial Cancer Research Fund are the following: the Duke of Bedford, £1,000 (third instalment of £3,000); Mr. J. A. Mullens, £100; the Clothworkers' Company, £50 and Mr. Archibald Walker, £50.

DR. W. BELL DAWSON, the engineer in charge of the Tidal and Current Survey of Canada, has been awarded the Gay prize of 1,500 francs, by the Academy of Sciences of Paris. This prize was offered for the best determinations of mean sea level on the coasts of the North Atlantic Ocean. Such determinations serve either to detect any gradual change of the land elevation relatively to the ocean, or to establish a plane of reference for general levels throughout the country. Although this is additional to the direct work of the Tidal and Current Survey as a marine undertaking, Dr. Dawson has evidently given special attention to this matter. As there are yet no general geodetic levels throughout Canada, he has established independent bench-marks at all the more important harbors and other localities where tidal observations have been obtained. These are at widely separated points, from Labrador to Nova Scotia, and from the St. Lawrence to Newfoundland. The resulting tide levels are described in his recent paper in the *Transactions of the Canadian Society of Civil Engineers,* entitled 'Tide Levels and Datum Planes in Eastern Canada.' It is the work there detailed, and explained in his other reports and papers on tidal subjects, that formed the basis of the award of the prize referred to.

MR. S. HARBERT HAMILTON announces that he has sold to the Carnegie Museum, Pittsburgh, Pa., the famous W. W. Jefferis collection of minerals, with the understanding that it is to be known in perpetuity as the 'W. W. Jefferis Mineral Collection of the Carnegie Museum.'

Mr. Jefferis began the collection of minerals more than seventy years ago. Living, as he did, at West Chester, Chester County, Pa., he had unusual opportunities of collecting choice specimens from the ancient gneiss, serpentine and limestones, as well as the trap rocks, of eastern Pennsylvania, New Jersey and New York. Mining was then carried on more extensively than now in this region. Mr. Jefferis's exertions were not confined by any means, for he traveled in northern New York, Canada and Europe in search of minerals. He conducted exchanges with collectors all over the world, sending out hundreds of boxes of minerals. He also spent as lavishly of his means as he did of his time in building up a marvelous collection with the eye of a connoisseur, so this which now goes to Pittsburgh is one of the finest private American collections. Mr. Jefferis, although primarily a collector, was also a discoverer and contributor to science. He furnished Geo. Brush, J. Lawrence Smith, C. U. Shepard, F. A. Genth, J. P. Cooke, J. D. Dana, F. W. Clark and many other investigators with material, as the files of original letters which go to Pittsburgh abundantly testify. Aquacreptite (Shepard), Euphyllite (Silliman, Jr.), Jefferisite (Brush), emerald nickel = Zaratite, Melanosiderite (Cooke), Roseite (Jefferis) were all discovered by Mr. Jefferis. In addition to new minerals Mr. Jefferis aided largely in extending the distribution of known species and in furnishing material for the reexamination of old and poorly known ones. Dana drew largely from Mr. Jefferis's notes and specimens, some of which were figured for his System of Mineralogy. Genth's 'Mineralogy of Pennsylvania' is also greatly indebted to Mr. Jefferis's labors in the field.

Miss Julia A. Lapham has been appointed chairman of the recently organized Landmarks Committee of the Wisconsin State Federation of Woman's Clubs. Under her leadership the ladies of the state are taking an active interest in the movement for the preservation of the animal effigy mounds and other prehistoric monuments and landmarks of Wisconsin. Miss Lapham lives at Oconomowoc and is the daughter of the late Dr. Lapham, the pioneer authority on the archeology of Wisconsin. It will be remembered that it was the women of Boston who saved the Serpent Mound of Ohio.

The books of the engineering library at the University of Michigan, which have hitherto been shelved in the general library, are soon to be transferred to a room set apart as a library in the new engineering building. The collection will be recatalogued and regarded hereafter as a department library. Miss Olive C. Lathrop has been appointed assistant librarian in charge of the collection.

During the past summer Mr. C. W. Purington, a mining engineer of Denver, accompanied by Mr. Sidney Paige as assistant, journeyed through Alaska, investigating, for the U. S. Geological Survey, the costs and methods of gold-placer mining in the territory. For the purpose of making comparative observations, he also visited the Atlin district of British Columbia and the Klondike gold fields of the Yukon territory. In studying the conditions which affect placer mining in our northern possessions, he was impressed with the present inadequate means of communication between the different parts of the territory. The gold mining which has been done in the interior of Alaska has been conducted in spite of difficulties of transportation which seem hardly credible. Mr. Purington advocates the appointment of a civil-service officer who shall be general superintendent of road construction in Alaska, and believes that there should be appointed, under the general superintendent, properly qualified road overseers in each district of Alaska. He also indorses the recommendation made by Mr. A. H. Brooks, geologist in charge of the division of Alaskan Mineral Resources, U. S. Geological Survey, that an appropriation of $1,000,000 be spent for wagon roads in Alaska. He thinks it probable that for this sum 900 miles of roads—300 of the Dawson standard wagon type and 600 for sleds—could be built in those parts of the country which would be most assisted by their construction.

Mr. Richardson, of Alabama, introduced in the House of Representatives, on January 23,

a bill which is sufficiently curious to deserve partial quotation. It begins: "*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Secretary of the Treasury be, and he is hereby, authorized and empowered and directed to pay, out of any money in the Treasury not otherwise appropriated, a sum not exceeding five hundred thousand dollars, for the organization and maintenance of an expedition, to be known as physical-phenomena association for the promotion of science expedition, the purpose of which shall be to seek, discover and investigate facts connected with the deep sea, the temperature, pressure, chemical properties, fauna, vegetation, character of the deep-sea bottom, volcanic disturbances and any and all phenomena relative to the ocean, for the cause and advancement of physical science generally. To facilitate the purpose of the expedition the Secretary of the Navy is authorized, immediately after the passage of this bill, to equip a ship suitable for said purpose, and to employ a first-class crew for the management of said ship. Immediately after the passage of this bill, or as soon thereafter as practicable, the President shall, with the concurrence of the Senate, appoint four chemists, who are learned in the science of chemistry, at a salary of three thousand dollars each per year; two geologists, who are learned in the science of geology; two astronomers, who are learned in the science of astronomy; two naturalists, who are learned in the science of natural history; two botanists, who are learned in the science of botany; two zoologists, who are learned in the science of zoology; and ten other scientists, if deemed practicable by the President, who are respectively learned in the sciences for which they are chosen, each at a salary of two thousand and five dollars per annum each. The President shall also appoint two persons, who are interested in the sciences generally, from each State, upon the recommendation of the Senators from each State, at salaries of three thousand dollars each, all of whom, after they shall have been appointed and confirmed as aforesaid, shall be members of the said expedition."

UNIVERSITY AND EDUCATIONAL NEWS.

The trustees of the Peabody Education Fund met at Washington on January 20 and voted to dissolve their trust. An appropriation of $1,000,000 for the George Peabody School for Teachers in Nashville, Tenn., was made by a unanimous vote, the state, county and city having together appropriated an equal sum for the school. This appropriation leaves a fund of approximately $1,200,000, which will be distributed later among other educational institutions, probably at the next annual meeting, which will be held next October in New York. The trustees have authority to distribute two-thirds of the fund in the south, and the remainder in the north, but it is probable the entire fund remaining will be devoted to southern institutions.

At the midwinter meeting of the trustees of Syracuse University it was voted to construct, with the bequest made to the university by the late John Lyman, which is said to aggregate more than $200,000, a building to be known as the John Lyman Laboratory of Natural History.

Mr. Andrew Carnegie has promised Oberlin College a gift of $125,000 for the erection of a library building, conditional on the raising of $100,000 for endowment by the citizens.

Mr. Adolph Lewisohn, of New York, has given $5,000 for the reconstruction of the chemical laboratories at Dartmouth College.

The New York Post-Graduate Medical School and Hospital has received an anonymous gift of $5,000.

Emperor William has directed the German ambassador to the United States to lay before President Roosevelt in official form the suggestion for an exchange of professors between German and American universities, which he made to the American ambassador on New Year's day. The German ambassador, who sailed on the *Kaiser Wilhelm der Grosse,* on January 25, only carries an outline of the project, for which the president's approval and cooperation in making a workable plan will be asked.

The Baltimore Association for the Promotion of the University Education of Women

is prepared to offer a fellowship of the value of $500 for the year 1905–1906. This fellowship will be available for work at either an American or a foreign university, and preference will be given to women from Maryland and the south. Application should be presented before April 12. Blank forms for application may be obtained from Miss McLane, No. 1101 North Charles Street, Baltimore.

The president of the British board of education has appointed the Right Hon. R. B. Haldane, K.C., M.P., to be chairman of a departmental committee "To inquire into the present working of the Royal College of Science, including the School of Mines; to consider in what manner the staff, together with the buildings and appliances now in occupation or in course of construction, may be utilized to the fullest extent for the promotion of higher scientific studies in connection with the work of existing or projected institutions for instruction of the same character in the metropolis or elsewhere; and to report on any changes which may be desirable in order to carry out such recommendations as they may make."

We noted last week that the regents of the University of Michigan, had refused to accept President Angell's resignation. Dr. Angell's communication to the board of regents was as follows:

To the Board of Regents:

I beg to tender you my resignation of the presidency of the university, to take effect Oct. 1, next. Although I have been graciously favored in the preservation of my health and strength, I am impressed with the belief that it will be advantageous to the university if you call a younger man to take my place.

I desire to express my sincere thanks to you and to your predecessors on the board for the kind consideration with which I have been treated by you and by them during my long term of service.

Should you so desire, I should be willing to continue to give instruction in international law.

Yours very respectfully,
James B. Angell.

The following resolution was immediately drawn up and unanimously adopted by the regents. Instead of being marked 'passed' as is customary with routine resolutions, it was submitted to each member and received his signature:

Resolved, That the Board of Regents respectfully decline to consider Dr. Angell's resignation of the presidency of this university. The members of this board are unanimous in the conviction that no other person, young or old, can take President Angell's place either in value of service to the university and to the state, or in the love of the people.

If at any time in the judgment of President Angell, he should need assistance in his work, the Board of Regents will most cheerfully furnish such assistance in such form as he may wish.

Mr. Louis Rouillion, adjunct professor of manual training in Teachers College, Columbia University, and director of the night schools of the Mechanics' Institute, has been given leave of absence in order to enable him to accept the appointment of chief inspector of technical education for Ireland.

At the recent meeting of the board of trustees of the Iowa State College, Professor S. A. Beach, horticulturist to the New York Experiment Station, was elected professor of horticulture, and horticulturist to the Iowa Experiment Station. This position has been vacant during the past year, due to the resignation of Professor H. C. Price, who resigned to become dean of the College of Agriculture of the Ohio State University. Professor Beach is an alumnus of the Iowa Institution and has been connected with the New York station for a number of years. He is now engaged in the publication of an important work on the pomology of New York for which the legislature made a special appropriation of $20,000. At the same meeting of the board Mr. A. T. Erwin, an assistant in the department, who has been the acting head during the past year, was elected associate professor of horticulture.

Mr. Thomas Case, Waynflete professor of moral and metaphysical philosophy, Oxford, and fellow of Magdalen, has been elected president of Corpus Christi College, in succession to the late Dr. Fowler.